THE ENGLISH ACADEMY:

Or, A Brief

INTRODUCTION

TO THE

SEVEN LIBERAL ARTS.

Grammar, *Arithmetick*, *Geometrie*, *Musick*, *Astronomie*, *Rhetorick*, & *Logick*.

To which is Added.

The Necessary *Arts* and *Mysteries* of *Navigation*, *Dyaling*, *Surveying*, *Mensuration*, *Gauging* & *Fortification*; Practically laid down in all their Material Points and Particulars, highly approved to be known by the Ingenious, and such as are desirous to Profit, or render themselves Accomplished.

Chiefly intended for the Instruction of Young Scholars, who are acquainted with no other than their Native Language; But may also be very useful to other Persons that have made some progress in the Studies of the said Arts.

The Second Edition.

By *John Newton*, [illegible]

LONDON, Printed by *A. Milbourn* at the *Three Bibles* and *Star*, on *Lu*[illegible]

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Licensed,

October 24th. 1677.

TO THE READER.

I Have perhaps troubled thee and the Preſs already too much; if it be ſo, I ſhall however hope, that I am not unpardonable, becauſe I have ſtill intended well to the good of the Publick; every one I think deſires to give their Children the beſt Education that they can; but the higheſt degree of Education is not always beſt: And I muſt beg thy Pardon, if I do offend thee, in ſaying, That next to the bare Reading of *Engliſh*, the ſending of Children to [illegible] School, is not the beſt [illegible] giving them Education, [illegible] if

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that were granted, which I must deny, That the *Latin* and *Greek* Tongues were not only necessary for all Children whatsoever, but also more easily learned, than the liberal Arts; yet *Writing* is so necessary to be first Learned, that it is almost impossible to attain the other without it.

And as *Writing* is very necessary in order to the *Latin* and *Greek* Tongues, so is it also necessary in order to the true Spelling and Understanding of the *English*, or any other Native Language; and indeed the Art of *Grammar* is the only One of the Seven, that claims a propriety in every Native Language. As for the other Arts, they are the same, in all Languages, the Rules of *Arithmetick* and *Geometry*, of *Musick* and *Astronomy*, of *Rhetorick* and *Logick*;

gish, are in the General, as Intelligible in every Language, as in the *Latin* and *Greek*, or any other; and therefore to them, that have no other need of the *Latin* and *Greek* Tongues, than the Learning of these Arts, may, I conceive, spare that pains, and Learn them in their own Native Language, or as many of them, as will be thought useful for them, in their several Stations in the World.

Again, these Arts are not only attainable in every Native Language, but more easily attainable than the *Latin* and *Greek* Tongues are, to which some seem desirous to confine the Arts; and being so attained, do render other Languages more easie also.

For these, and the like Reasons as I have already Published [illegible] Introductions to every Art, [illegible]

[illegible]

Muſick; for which I refer thee to Mr. *Joh. Playford's* Introduction; ſo now I have been eaſily perſwaded, to give thee a ſhort view of them altogether; he that deſires more full Inſtruction, may peruſe the ſeveral Tracts by me Written, in our own, or thoſe that are Written by other Men in other Languages. The whole Building is but ſmall, and therefore I will not make the Porch great, I have placed the Arts in that Order, in which, (with ſubmiſſion to better Judgments) I do conceive they ſhould be learned: And although I cannot ſay now, as I have in ſome of my Epiſtles preceding my former Tracts, that there is not ſo much as one *Mathematical School* in *England*, for now there is by the Bounty of King *Charles* the *Second* a fair one Erected in *Chriſts Hoſpital*, *London*,

and

and a worthy Master chosen to Manage it, by Name Mr. *Edward Paget*, who is so well known, that he needeth no Mans Commendations to express his VVorth; Yet thus much I still declare to be my opinion, That it is more proper, that the *Latin* School should be supplied with Scholars from the *Mathematical*, than that the *Mathematical* should be supplied from the *Latin* and *Greek* Schools: However by this means, I hope it will come to pass, that after-ages will be supplied with that Knowledge in *Arithmetick*, *Geometry*, and *Astronomy*, which hitherto our *Writing*-Masters have not been able to Teach, nor our *Grammar* Masters either able or willing to undertake; so that in a Word, There are few School-Masters that can Teach these things:

things: But yet amongst them the well Accomplished Mr. *John Colson*, now living in *Goodmans-fields*, with whom I have not had the happiness to be immediately Acquainted, yet Report hath rendred him to the World a worthy Master and Teacher of that Science. And there are not many Tutors in either of our Universities that do; and yet the usefulness of these Arts cannot be denied, and therefore my hopes are, that some Universal Encouragement will yet be given for the Teaching of them.

And could I be so happy, as to see something done in order to it, I should think my self abundantly satisfied for all the Pains I have hitherto taken, and shall ever rest,

Thine and his Countrys Servant,

JOHN NEWTON.

THE PREFACE OR, INTRODUCTION TO THE *Arts* and *Sciences* in the General,

Wisdom is the principal thing, and therefore saith Solomon, Get Wisdom, and with all thy getting, get Understanding. Pro. 4. 7. *And what is meant by Wisdom, Holy* Job *tells us*, Job 28. 28 Behold the Fear of the Lord, that is Wisdom, and to depart from Evil, that is Understanding. *They who seek for this Wisdom,*

Wisdom, are the only true Philosophers: *for* Philosophy *is nothing else but the love of Wisdom, and they who Fear God, and depart from Evil, are the lovers of that, which is only real and true Wisdom: Now for as much, as we cannot be said to fear God, except we know him, Wisdom may well be defined to be the Knowledge of God, and the things that are of him, the knowledge of things Divine and Humane, and this is commonly called* Philosophy, *but somewhat improperly, for* Philosophy *is not properly the Knowledge it self, but the love of that Knowledge; and whatsoever* Art *or* Science *doth conduce to this Knowledge, may rightly and truly called* Sophia, *or* Wisdom; *and because all Men should love this Knowledge and Delight in it, I shall not gainsay the general Name by which it is called, custom will have it so, let it therefore be called* Philosophy.

Sophia then, *or* Philosophia, Wisdom, *or the love of* Wisdom, *is the Knowledge of all Arts and Sciences, which any way*

more, some less: These arts may be distinguished into two Sorts, Superiour and Inferiour.

The Superiour Arts are four;

1. Theology or Divinity, whose Subject is the Divine Essence.

2. Metaphysicks, otherwise called the first Philosophy, whose Subject is, Being in common, or Being as Being.

3. Physicks, whose Subject is the Knowledge of Natural Bodies, as they are Natural.

4. Ethicks, whose Subject is Morality, or the Doctrine of Manners and Civil Honesty.

The Inferiour Arts are of two sorts;

1. Internal or Liberal Arts, so called, because they are attained by the faculties of the Soul, which is a liberal or free agent, and not by the Labour or Ministry of the Hands; and these are seven:

1. Grammar,
2. Arithmetick,
3. Geometry,
4. Musick,
5. Astronomy,
6. Rhetorick,
7. Logick.

And these are the Subjects of this little Book.

2. The External *or* Mechanical *and* Manual Arts, *so called, because they depend more upon the labour of the Body, than the Mind; such are the Arts of* Tillage; Hunting, Fishing, Fowling, Weaving, *and many more, not needful to be named, because no part of the ensuing Discourse.*

THE

THE *ENGLISH* ACADEMY,

The FIRST PART,

OF GRAMMAR.

BOOK I.

CHAP. I.

Of Letters and Syllables.

Grammer is an ART which Teacheth how to Speak and Write truly.

The Parts thereof are Four, Letters, Syllables, Words, and Sentences.

A Letter is a Character, or Index, of a ſimple ſound. And in the *Engliſh* Tongue there are Twenty four.

The which Letters are diſtinguiſhed from one another, partly by their ſhapes, and partly by their ſounds.

In reference to their ſhapes, they are diſtinguiſhed by three different Characters, the *Roman*, *Italick*, and black *Engliſh*.

And in each of theſe Characters there is the great and the ſmall Letter.

In the *Roman* Character, the Great Letter is thus formed,

A, B, C, D, E, F, G, H, I, J, K, L, M, N, O, P, Q, R, S, T, U, V, W, X, Y, Z.

The ſmall thus,

a, b, c, d, e, f, g, h, i, j, k, l, m, n, o, p, q, r, ſ, s, t, u, v, w, x, y, z.

The great and ſmall *Italick* Letters are made thus,

A, B, C, D, E, F, G, H, I, J, K, L, M, N, O, P, Q, R, S, T, V, U, W, X, Y, Z.

a, b, c, d, e, f, g, h, i, j, k, l, m, n, o, p, q, r, ſ, t, u, w, x, y, z.

The great and ſmall black *Engliſh* thus,

𝔄, 𝔅, ℭ, 𝔇, 𝔈, 𝔉, 𝔊, ℌ, ℑ, 𝔎, 𝔏, 𝔐, 𝔑, 𝔒, 𝔓, 𝔔, ℜ, 𝔖, 𝔗, 𝔘, 𝔙, 𝔚, 𝔛, 𝔜, ℨ,

𝔞, 𝔟, 𝔠, 𝔡, 𝔢, 𝔣, 𝔤, 𝔥, 𝔦, 𝔧, 𝔨, 𝔩, 𝔪, 𝔫, 𝔬, 𝔭, 𝔮, 𝔯, 𝔰, 𝔱, 𝔲, 𝔳, 𝔴, 𝔵, 𝔶, 𝔷.

The great Letters are uſed in the beginning of proper Names, Emphatical words, Sentences, and Verſes. The Letter I when it ſtands alone, is always written with a great Character.

Theſe

These Twenty and four Letters are divided into Vowels and Consonants.

A Vowel is a letter which maketh a full and perfect sound of it self, and they are five, *a*, *e*, *i*, *o*, *u*, besides the *Greek* Vowel *y*.

A Consonant is a letter which maketh a sound by help of a Vowel, and these are Eighteen, besides the letters *j*, *v*, and *y*, which sometimes are Consonants also.

Of the eighteen Consonants, some are mutes, as these eight, *b*, *c*, *d*, *g*, *k*, *p*, *q*, and *t*. Some semi-Vowels, as these eight, *f*, *l*, *m*, *n*, *r*, *s*, *x*, and *z*, of which these four, *l*, *m*, *n*, *r*, are also called Liquids, *x*, and *z*, double Consonants, and the other two, *h*, and *w*, irregular Letters.

Some of these Letters, as well Vowels as Consonants, have sounds very different from their common names. Thus the letter *c*, before *e*, and *i*, is sounded like *s*, but before *a*, *o*, *u*, it is sounded like *k*, as in *cat*, *cot*, *cut*.

The Letter *f*, is sometimes sounded according to its usual name, as when it follows a Vowel, as in *if*, *of*, *effeminate*, but when it begins a Word or Syllable, it is sounded *fee*, as in *feet*, *foolish*.

The Letter *g*, before *a*, *o*, and *u*, is sounded hard, thus, *ghee*, as in *gad*, *God*, *gut*, but before *e* and *i* it is sometimes, but not always, sounded according to its usual name *gee*, as in *danger*, *ginger*.

The Letter *h*, is never sounded according to its name *ach*, but thus, *hee*, as in *hand*, *help*, *him*.

The letters *j* and *v*, when they come before themselves, or any other Vowel in the same Syllable, become Consonants, and have different sounds from their usual names, *j* is pronounced like *g* soft, thus *ji* is pronounced like *gi*, in *ginger*, *v* is pronounced *vee*, or *vu*, as in *vanish*, *vine*; and when they are thus sounded, their shape is also changed, and hence some would have them to be distinct letters, and would have the number of our letters to be not 24. but 26.

The Liquids *l*, *m*, *n*, and *r*, when they begin a Word or Syllable, are sounded thus, *lee*, *mee*, *ree*, as in *light*, *mind*, *need*, *read*.

The letter *q*, hath always *u* after it, to help its sound, but is not to be sounded according to its name *cu*, but *que*, as in *question*.

The letter *s*, when it begins a word or Syllable is to be sounded thus; *see*, as in *sad*, *secret*, but in the end of a word, or between two Vowels or Diphthongs, it hath for the most part the sound of *z*, as in *easie*, *bosom*.

The letter *t* before *i*, if another Vowel followeth, hath the sound of *si*, as in *Egyptian*, *patience*; but when it followeth *s* or *x*, it hath its own proper sound, as in *bestial*, *mixtion*.

The letter *w*, hath its name from its shape, being composed of twice *u*, it is called double *u*; but is in no case so sounded, but *we*, as in *wall*, *well*, *will*.

The

The letter *x*, when it begins a word or Syllable, is sounded thus, *zee*, as in *Xerxes*; in other cases thus, *ex*, or *ecs*.

The letter *y* hath by no means its sound according to its usual name *wi*, but when it begins a word or Syllable, and so becomes a Consonant, it is sounded *yee*; when it comes in the middle or end of a word, it is sounded like *i* Vowel, as in *my*, *sky*.

The letter *z* is to be sounded *zee*, as in *Zeal*.

A Syllable is a literal or articulate Voice of one individual sound.

Syllables are of two sorts, improper and proper.

An improper Syllyble is made of one or more Vowels without a Consonant; as *a-ny*, *e-vil*, *Æ-neas*, *Oe-dipus*.

A Proper Syllable is the comprehension of one or more Consonants, with one or more Vowels, in one sound or breath; as *Ge-ne-ra-ti-on*, *Moun-tain*, and in our *English* Tongue doth sometimes consist of eight letters, as *strength*.

When two Vowels are joyned together in one sound or breath, they are called Dipthongs, of which there are two sorts, Proper and Improper.

Of proper Dipthongs, there are these eight, *ai*, *ei*, *oi*, *au*, *eu*, *ou*, *ee*, and *oo*.

The first six are sometimes written thus, *ay*, *ey*, *oy*, *aw*, *ew*, *ow*.

Of improper Dipthongs there are but these three, *ea*, *oa*, and *ie*.

The two Vowels which make a Dipthong, are for the most part to be sounded together, as in *Faith*, *neither*, *Eunuch*, but in these words, *Laity*, *Mosaick work*, *Deity*, *Atheist*, *moity*, *doing*, *reenter*, *reiterate*, and such like; and in most Proper Names in the Bible they are to be sounded severally.

The Improper Dipthongs *ea*, and *oa*, are sounded together, except in these words, *beatitude*, *Creator*, *creation*, *real*, *theatre*, and most proper names of Women, Cities, and Countries; but the two Vowels in this Dipthong *ei*, are usually parted, except in these two words, *friend*, *grief*, and when they come in the end of a word, as in *mercie*, *charitie*, and such like.

An *English* syllable, though it may consist of eight letters, yet doth it never begin with more than two Vowels before a Consonant, of three Consonants before a Vowel or Dipthong.

The two Consonants which may begin an *English* word or syllable, are these thirty, *Bl*, *br*, *ch*, *cl*, *cr*, *dr*, *dw*, *fl*, *fr*, *gl*, *gn*, *gr*, *kn*, *pl*, *pr*, *sc*, *sh*, *sk*, *sp*, *sl*, *sm*, *sn*, *sq*, *sw*, *th*, *tr*, *tw*, *wh*, and *wr*.

And the three Consonants that may begin an *English* word, are these nine, *Sch*, *scr*, *shr*, *skr*, *spl*, *spr*, *str*, *thr*, *thw*.

In the sounding of the Consonants, which are

are joyned together in the beginning of a word, there is no difficulty, but in these few, *ch*, *gh*, and *th*.

The letters *ch*, when they come before a Vowel in a pure *English* word, they are to be sounded as in *chance*, *cheap*; and when they come after a Vowel, they are to be sounded, as in *ach*, *reach*, *rich*. But in words derived from the *Greek* and *Hebrew*, they are to be sounded like *k*, as in *character*, these few only excepted, *Rachel*, *Cherubin*, *Tychicus*, *Arch-Bishop*, *Arch-Duke*, *Architect*, *Arch-enemy*, *Arch-pirat*.

The letters *gh*, in the beginning of a word, are to be sounded like *g* hard, as in *ghost*, *ghess*, in the middle of a word, they are either not sounded at all, or but softly, as in *might*, *light*, and in the end of a word they have the sound of *ff*, as *tough*, *rough*.

These letters *th*, in words of one syllable, and in words of more than one, ending in *ther*, *thed*, *theth*, *thest*, *thing*, they have the sound of *d*, in other words the sound of *t*, or the Greek *Theta*.

The letters *ph*, never begin a pure *English* word, but such only as are derived from the *Greek* and *Hebrew*, as *Pharisee*, *Pharez*, *Epitaph*, and in these they are sounded like *f*.

The Liquids, *l*, *m*, *n*, *r*, when another Consonant doth precede them in the beginning or middle of a word, do retain their own sound, but in the end of a word, though

the Vowel *e*, ought to be written, yet in the pronounciation, you must stop at the two Consonants, and omit the Vowel; for Example, *fable*, *acre*, *uncle*, must be pronounced as though they were written thus, *fabl*, *acr*, *uncl*.

CHAP. II.

Of Words.

A *Word*, is such a comprehension of letters and syllables, as helpeth Man-kind to express their minds to one another.

There are eight kinds of Words, or parts of Speech, *Noun*, *Pronoun*, *Verb*, *Participle*, *Adverb*, *Conjunction*, *Preposition*, *Interjection*.

A *Noun*, is the name of a Person or Thing; as, an *Author*, a *Book*, *learned*, *guilded*.

Of *Nouns*, some be *Substantives*, and some be *Adjectives*.

A *Noun Substantive*, is a Word, that signifieth something, and may have the sign (*a*) or (*the*) before it; as, *a Man*, *the Book*.

A *Noun Adjective*, is a Word, that cannot signifie a thing of it self; as, *good*, *bad*.

There are two sorts of *Nouns Substantives*.

A *Noun Substantive* proper, and a *Noun Substantive* common.

A *Noun substantive* proper, is a *Noun* that is proper to the person or thing, that it betokeneth; as, *Henry*, *England*.

A

A *Noun substantive* common, is a *Noun* common to all things of the same kind; as, *a Man, a Land, an Angel.*

To a *Noun* there doth belong two things, number and comparison.

There be two *Numbers*, the *singular* and the *plural*; the *Singular number* speaketh but of One; as a *Man*, a *Book*, a *Stone*. The *Plural number* speaketh of more than One; as, *Men, Books, Stones.*

Nouns substantive of the *singular number*, are turned into the *plural*, by adding unto them *s* or *es*, as *web, webs, robe, robes, Church, Churches, hedge, hedges.* Some *Nouns* of the *singular number* ending in *f*, being *plurals*, do change *f* into *v*, as, *beef, beeves, calf, calves.* And some are made *plurals*, by adding of *en* or *ren*; as, *Ox, oxen, chick, chicken, brother, brotheren*, or by contraction, *brethren, child, children*; of *Man* is formed *mannen*, or *men*, *house, houses, louse, lousen*; to which may be added, *mouse, mice, louse, lice, die, dice, sow, swine, cow, kine, penny, pence, goose, geese, tooth, teeth, foot, feet*; these two, *Sheep* and *Mile*, are both *singular* and *plural*, as, *one sheep, ten sheep, one mile, ten mile* or *miles.*

Other variation of *Nouns* we have none in the *English* Tongue; all other distinctions are made by these Articles and Prepositions; *a, of, to, the, o*, and *in*, or *from*, &c.

Nouns that signifie the Male-kind, we call *Hes*; such as signifie the Female, we call

sacer; and of such as signifie neither, we say in as, *Esau* could not obtain his Fathers blessing, though *he* sought *it*, with tears. *Jezabel* was a wicked woman, for she slew the Lord's Prophets.

Comparison belongeth only to *Nouns Adjectives*, whose significatoin may be increased or diminished.

There be three degrees of *Comparison*, the *Positive*, *Comparative*, and the *Superlative*.

The *Positive degree* setteth down the quality of a thing absolutely without excess, as *hard*, *soft*, *swift*.

The *Comparitive degree* raiseth the signification of the *Positive*, in comparison of some other, as *harder*, *softer*, *swifter*.

The *Superlative* exceedeth his *positive* in the highest degree, as *hardest*, *softest*, *swiftest*.

Adjectives are compared in the *English* tongue, either by the signs *more* and *most*, or by the terminations *er*, and *est*, as *hard*, *harder*, or *more hard*, *hardest*, or *most hard*.

Some *Adjectives* are compared irregularly, as, *Good*, *better*, *best*; *bad*, *worse*, *worst*; *little*, *less*, *least*.

CHAP. III.

Of a Pronoun.

A *Pronoun* is a part of Speech much like to a *Noun*, implying a Person, and not admitting the sign *a* or *the*, before it. There

There are twelve *Pronouns*, *I*, *Thou*, *He*, *who*, *which*, *that*, *the same*, *my*, *thy*, *this*, *his*, *whose*.

Of *Pronouns*, some be *primitives*, and some *derivatives*.

Pronoun primatives are of three sorts, *Personal*, *Relative*, and *Demonstrative*.

There are three *Pronoun personals*, *I*, *Thou*, and *He*.

Pronoun Relatives, are likewise three, *who*, *which*, and *that*.

Pronoun Demonstratives, are these two, *this*, *the same*.

Pronoun Derivatives, are these four, *my*, *thy*, *his*, *whose*. All which with their variations, are expressed in the following Type.

Possessives.

1. Person.	*Sing.*	I, me, my, mine.
	Plur.	we, us, our, ours.
2. Person.	*Sing.*	thou, thee, thy, thine.
	Plur.	ye, you, your, yours.
3. Person.	*Sing.*	*Mas.* he, him, his.
		Fem. she, her, hers.
		Neuter it, its.
	Plur.	they, them, their, theirs
Relatives.	*To pers.*	who, whom, whose.
	To thing.	what, whereof.

Own

Own is a *Noun adjective*, and *self*, or *selves*, a *Substantive*, but are sometimes joyned to, or compounded with the *Pronouns*; as, *my self*, *thy self*, *themselves*, *his own self*, *their own selves*.

This word *where*, with certain Prepositions following it; as, *about*, *at*, *by*, *in*, *of*, *unto*, *with*, hath the signification of *which* as, *wherein*, or *in which*. And these words, *here*, *there*, and in like manner used for, *this*, *that*; as, *herewith*, *therewith*, for *with this*, *with that*.

CHAPTER IV.

Of a Verb and Participle.

A *Verb* is a part of Speech, that joyneth the Signification of other words together.

There are three kinds of *Verbs*, *Active*, *Passive*, and *Neuter*.

A *Verb Active*, is a *Verb* that betokeneth doing, as, *I love*.

A *Verb Passive*, is a *Verb* which betokeneth suffering, as *I am loved*.

A *Verb Neuter*, is a *Verb* which betokeneth being, as *I am*.

Four things belong to a *Verb*, *Mood*, *Tense*, *Number* and *Person*.

There are four *Moods*, the *Indicative*, the *Im-*

Imperative, the *Potential*, and the *Infinitive*.

The *Indicative* either sheweth a reason true or false, as *I love*, or asketh a Question, as, *dost thou love*.

There *Imperative Mood*, intreateth, permitteth, or commandeth, as *love be*, or *let him love*.

The *Potential Mood*, signifieth a power, duty, or desire, and hath one of these Signs, *may*, *can*, *might*, *would*, *should*, *could*, or *ought*, as *I may or can love*.

The *Infinitive Mood*, notes no certain Number or Person, but followeth another *Verb*, or an *Abjective*, and hath commonly this Sign (*to*) before it, as *I desire to learn*, *worthy to be praised*.

The *Tenses* or distinctions of Time, are five, The *Present Tense*, the *Preterimperfect Tense*, the *Preterperfect Tense*, the *Preterpluperfect Tense*, and the *Future Tense*.

These *Tenses* in respect of signification, are thus distinguished; in the *Indicative Mood*, *do* is the sign of the Present Tense, *did* of the preterimperfect Tense, *have* of the Preterperfect, *had* of the Preterpluperfect, *shall* and *will* of the Future,

In the *Potential Mood*, by the signs already given, the Present Tense by the signs *may* or *can*, the Preterimperfect *would*, *should*, *could*, or *ought*, and the Preterperfect, by annexing the sign have to the former Signs, and the Future, by adding *hereafter* to the

ſigns of *may* or *can*, the Signs of the Preſent; as, *I may or can hereafter*, the Preterpluperfect in this Mood is wanting in the *Engliſh* Tongue.

But in reſpect of Termination, there are no Moods but one, no Tenſes but two, namely, the *Preſent*, and *Preterimperfect* Tenſes.

And the Preterimperfect Tenſe is formed from the Preſent, by adding thereto the termination (*ed*) and in ſome few the termination (*en*) as of *love* is formed *loved*, of *fall*, *fallen*.

The Perſons in every Tenſe are diſtinguiſhed by the perſonal Pronouns, *I*, *Thou*, and *He*, in the Singular Number, and *We*, *Ye*, *They*, in the Plural; only the Second Perſon Singular in the Preſent and Preterimperfect Tenſes is formed from the firſt, by adding thereto the Termination *eſt*, as of *love*, *loveſt*, of *loved*, *lovedſt*; and the Third Perſon Singular in the Preſent Tenſe is formed from the Firſt, by adding thereto the Termination (*eth*) as of *love* is formed *loveth*. other variations of Perſons or Tenſes there is none, but what is done by Signs, as was ſaid before.

A *Verb Active* then is thus formed in the *Indicative Mood*.

Preſent Tenſe.

Sing. Love, loveſt, loveth. *Plur.* Love, *Infinitive*, To love.

Pre-

Preterimperfect Tense.

Sing. Loved, lovedst, loved. *Plural.* Loved.

This *Verb Neuter*, *Am* or *Be* is thus formed.

In the *Present Tense.* { Am, art, is, } *Plur.* Are.
{ Be, beest, be } *Plur.* Bee.

In the *Preterimperfect Tense.* { Was, wast, was, } *Plural.*
{ Were, wert, were, } Were.

Infinitive. To be.

A *Verb Passive*, is the same throughout all Moods and Tenses, with a *Verb Neuter*, the *Preterimperfect Tense* of the Active Voice, being added thereunto; Thus the Passive Voice of this Verb Active, *I love*, is formed, by adding *loved* to all the Tenses and Persons of this Verb Neuter, *I am.*

For Example.

The *Present Tense* of the *Indicative Mood* is thus formed,

I am loved,
Thou art loved,
He is loved.
} We
Ye are loved,
They

A *Participle* is a part of Speech, derived of a Verb, from which it hath Signification, of Time present, past, or to come.

There are two *Participles*, one of the Active, and another of the Passive Voice.

The *Participle* of the Active Voice is derived from its Verb, by adding the Termination (*ing*) to the *Present Tense*; as of *love*, *loving*.

The *Participle* of the Passive Voice is for the most part, the same with the *Preterimperfect Tense* of the Active; as the *Participle* of the Passive Voice in this Verb *love* is *loved*.

From this General Rule many Verbs are Excepted, for of

	Is formed		
Make	made	take, took, taken
lead	led	shake, shook, shaken
bereave	bereft	seeth, sod, sodden
smell	smelt	shear, shore, shorn
seek	sought	rise, rose, risen
beseech	besought	give, gave, given
think	thought	strive, strove, striven
work	wrought	sing, sang, sung
buy	bought	know, knew, known
grinde	ground	throw, threw, thrown
stand	stood	go, went, gone,

Of these, see more in my School Pastime.

CHAP.

CHAP. V.

Of Adverbs, Conjunctions, Prepositions, and Interjections.

AN *Adverb* is a Word joyned to a Verb or Noun, to declare their Signification.
Some of Time, as *when, now, then, to day.*
Some of Number, as, *how oft, once, twice.*
Some of Order, as, *first, next, afterward.*
Some of Place, as *where, here, there.*
Some of Affirming, as, *yea, perhaps.*
Some of Denying, as, *no, not.*
Some of Shewing, as, *lo, behold.*
Some of Similitude, as, *so, how much, more.*

A *Conjunction* is a part of Speech, which joyneth Words and Sentences together, of which these are some, *And, also, likewise, nor, neither, whether, or, either, but, for,* &c.

A *Preposition,* is a Word commonly set before other parts of Speech, either in apposition, as *before the Master,* or in composition, as *overwise.*

An *Interjection* is a Word, expressing some suddain passion of the Mind, *oh, alass, O strange, ho, hark, sirrah.*

CHAP.

CHAP. VI.

Of Dividing of Words into Syllables.

FOr the dividing of Words into Syllables there are four Rules.

1. Two Vowels which make no Dipthong, must be divided; as, *ie*, *iu*, *ua*; as in *qui-et*, *tri-umph*, *mutu-al*.

2. Those Consonants which are doubled in the middle of a Word, must be divided; as in *Abba*, *accord*, *adder*.

Except they be needlesly doubled, as in words of the *Plural Number*; as in *crabbs*, *rodds*.

Except such words in which they are doubled for distinction sake; as in the words, *Ann*, *Cann*, *Inn*.

3. *Rule.* When a Consonant cometh between two Vowels, it is to be joyned to the latter; as in *a-vail*, *a-ni-mate*.

But to this Rule there are four Exceptions

1. Except Words ending in *es*, as in *Nouns*, of the *Plural Number*, and *Verbs* of the *third person Singular*, in which this particle is for the most part swallowed up, in the former Syllable; but in all proper Names, except *Charles* and *James*, it makes a distinct Syllable.

2. Except Words that are compounded of such Simple Words, as are significant a-

part,

part, in which each Simple Word must retain its own letters; as, *Tradeſ-man, ſafe-guard, hence-forth.*

3. Except *Derivative* Words, whoſe addition to the *Primitive*, doth ſignifie nothing of it ſelf, in which the *Primitive* muſt be ſounded by it ſelf, and the addition by it ſelf; as, *hope-leſs, lay-ing, joyn-ing*, and ſuch like.

4. Except ſuch Words in which *x* cometh between two Vowels, in which it muſt be joyned to the firſt Vowel; as, *ox-en, ex-erciſe.*

5. *Rule.* Any two or three Conſonants, which may be joyned together in the beginning of a word, are not to be ſeperated in the middle; as in *a-gree, beſtow, en-thrall; deſtruction*; but in compounded words, each ſimple word muſt retain its own Letters.

When you are to write any hard long word, mark how many ſounds or Syllables it hath, as if you were to write *diſdainfulneſs, univerſalitie*, or the like, before you write it, ſay thus to your ſelf; *diſ-dain-ful-neſs, u-ni-ver-ſa-li-tie*, and you ſhall hardly miſs in the writing thereof.

CHAP.

CHAP. VII.

Of Sentences, and such Distinctions, or Points as are to be used in Writing, and observed in Reading.

A *Sentence*, is a number of words, joyned together in perfect Sense.

The Stops or Points to be observed in *Sentences*, are of two sorts, *Primary*, and *Secundary*.

The *Primary* Points are these Eight.

1. A *Comma*, made with a little stroke thus (,)
2. A *Colon*, made with two points thus (:)
3. A *Semi-colon*, made with a point, and a little stroke under it thus (;)
4. A *Period*, made with a single point thus (.)
5. An *Eroteſis* or *Interrogation*, made in this manner (?)
6. An *Ecphoneſis*, or note of *Admiration*, whose note is a perpendicular right line, with a point under it thus (!)
7. A *Parentheſis*, is a note, like two half Moons, including a sentence, which may be used or omitted, and yet the sense remain intire, thus ( )

8. A

8. A *Paratheſis*, is a note, which doth include a word which is oppoſed to another word, and is made with two *Semiquadrats*, thus [ ]

The *Secondary* Points are theſe ſix.

1. An *Apoſtrophe*, which is a note, ſet on the top or ſide of a Letter, whereby two Syllables are contracted into one, and is made like a *Comma*, thus (') as *it's for it is*.

2. An *Eclipſis*, which is a note cutting off one or more words in the beginning or ending of a Verſe or Sentence, cited in our Writing, and is made with a long ſtroke thus —— as

——————— *Princes are not wiſe,*
Who ſleep themſelves, and truſt their ſervants
(*Eyes.*

3. A *Dieresis*, which is a note for the parting of two Vowels, which otherwiſe might ſeem to make a *Dipthong*, and is made with two pricks over the two Vowels, thus, (¨) as in *Laïs*.

4. An *Hyphen*, which is a note of continuation, made thus (-) and is to be uſed when one part of a word concludeth the former line, and the other part beginneth the next; or elſe, when two words are, by way of Elegancy, as it were

joyned into one; as *self-love*, for the love of ones self.

5. An *Accent* which is a small stroak drawn slopewise towards the left-hand, thus, (') and is to be set over that Syllable in a word, which is to be pronounced long.

6. A *Circumflex*, which is the joyning together of two oblique stroaks into one figure, one of them being made towards the right hand, and the other towards the left, and is to be set over a Vowel, thus, (â) which is to be pronounced long, as in *bîte*, *wîle*, *stîle*, not in *bit*, *will*, *still*.

The *Accent* in words of many syllables is commonly placed on the third Vowel from the last; as in *toleràtion*, *industry*.

But words ending in (*ary*) have the accent on the first syllable; as *témporary*; words that have many Consonants in the last syllable save one, have their accent on that syllable, as in *etérnal*; words ending in *ire* and *ure*, have their accent in that syllable; as *inúre*.

A *Noun* hath its accent in the first, a *Verb* in the last syllable; as *ábsent*, to *absént*.

So *Húmane*, when it comes before a *Substantive*, as *humane-learning*; but in the last syllable, when it comes after a *Substantive*, as *Christ had two natures*, the one *divine*, the other *humane*.

THE

THE *ENGLISH* ACADEMY.

The SECOND PART.

Of ARITHMETICK.

CHAP. I.

Of single Arithmetick in whole Numbers.

ARithmetick is the art of accompting by Numbers; it is either *positive* or *negative*.

2. *Positive Arithmetick*, is that which is wrought by certain and infallible Numbers at first propounded; and this is either *single* or *comparative*.

3. *Single*, which is wrought by Numbers, considered alone, without relation to one another, and this either in whole Numbers, or in Fractions.

4. The parts of *single Arithmetick*, are two, *Notation* and *Numeration*.

5. *Notation* hath two parts; the first sheweth the value of the Notes, by which all numbers are expressed; the second sheweth how to read the Numbers which are expressed by those notes.

6. The Notes or Characters, by which all Numbers are usually expressed are these, 1. *one*, 2. *two*, 3. *three*, 4. *four*, 5. *five*, 6. *six*, 7. *seven*, 8. *eight*, 9. *nine*, 0. *nothing*.

7. These notes are either significant Figures, or a Cypher.

8. The significant Figures, are the first nine, *viz.* 1, 2, 3, 4, 5, 6, 7, 8, 9. The first whereof is more particularly termed an *unite* or *unite*, the rest are said to be composed of *unites*; so 2, is composed of two *unites* 3, of three *unites*, &c.

9. The *Cypher*, though it signifie nothing of it self, yet being set before or after any of the rest, increaseth or decreaseth their value, as shall be further shewed hereafter.

10. The second part of *Notation*, is the reading of the Number expressed by these notes; and this is done by distinguishing the Number given into Degrees and Periods.

11. The degrees are three, the first is that first place of a number towards the right hand, and is the place of Unity. The second is the second Figure towards the right hand, and this is the place of Tens. The third is the

third

third Figure towards the right hand, and is the place of Hundreds; ſo this Character 9, doth ſignifie Nine; theſe Notes 27, Twenty ſeven; and theſe 235, Two hundred thirty five.

12. A *Period*, is when a number conſiſting of more notes than three, hath each three notes thereof (beginning at the right hand) diſtinguiſhed by Points or *Commas*: The ſeveral parts of the Numbers ſo diſtinguiſhed, are called *Periods*; ſo the Number 38156249, being diſtinguiſhed into *Periods*, will ſtand thus, 38.156.249. of which the firſt Period is read thus, Two hundred forty nine; the firſt Figure in the ſecond *Period* is the place of Thouſands, the ſecond Tens of Thouſands, and the third Hundreds of Thouſands. In the third *Period*, the Figure is in the place of Millions, the ſecond Tens of Millions, and ſo this Number is thus to be read, Thirty Eight Millions, One Hundred Fifty Six Thouſand, Two Hundred Forty Nine.

13. *Numeration*, is that which by certain known Numbers propounded, doth diſcover another Number unknown.

14. *Numeration* hath four Species; *Addition*, *Subtraction*, *Multiplication*, and *Diviſion*.

15. *Addition*, is that by which divers numbers are added together, to the end that the Sum or Total may be diſcovered. For which purpoſe, having placed the numbers as in the following Example, begin with thoſe in the

Unity place first, then with these in the place of Tens, then of Hundreds, and so forward, according as the Numbers given do consist of places, carrying the Tens, if there be any, to the place of the next greater rank, as here you see.

472961	3814527
341608	4567890
74325	6549238
6739	816365
895633	15748020

16. *Subtraction* is that, by which one number is taken out of another, so that the Reliue or remainder may be known. To perform this, you must rank your Numbers, and begin as in *Addition*; and in case any of the figures of the Number to be subtracted shall be greater than that, from whence the Subtraction is to be made, you must borrow one from the next place above it; as in the Examples following.

895633	6549238
341695	3814527
553938	2734711

17. *Multiplication*, is that by which we Multiply two numbers, the one by the other, to the end, that their Product may be discovered.

18. *Multiplication* hath three Parts, the *Multiplicand*, the *Multiplicator*, and the *Product*.

19. *Multipli-*

19. *Multiplication*, is single or compound.

20. Single *Multiplication*, is when the Multiplicand, and Multiplicator, do each of them consist of one only Figure; as if 9 were given to be Multiplied by 6, 9 is the Multiplicand, 6 is the Multiplicator, and 54 is the Product.

21. Compound *Multiplication*, is when the Multiplicator and Multiplicand do either, or both consist of more Figures than one.

22. When the Product of any of the particular Figures shall exceed ten, place the Excess under the Line, and for every ten that is so exceeds, keep in mind one to be added to the next rank: *Example*, 7647, being to be Multiplied by 5, the Product is 180735, and 39634 being given to be Multiplied by 47, the work will stand as in the Margin, where the Product by 7 is 277438, and the Product thereof by 4, is 158536, and the Sum of these two Products is 1862798.

	39634
	47
	277438
	158536
	1862798

23. *Division* is that by which we discover how often one Number is contained in another, that we may find out the Quotient.

24. *Division* hath three Parts, the *Dividend*, the *Divisor*, and the *Quotient*; thus, if 35 were given to be Divided by 5, 35 is the *Dividend*, 5 the *Divisor*, and 7 will be found to be the *Quotient*.

25. In *Division*, make a crooked line at each end of your *Dividend*, that on the left hand serving for your *Divisor*, and that on the right for the *Quotient*; then see how oft your *Divisor* is contained in the first Figure or Figures of your *Dividend*, and put the answer in the *Quotient*, then Multiply your *Divisor* by the Figure in the *Quotient*, and the Product subtract from your *Dividend*, then draw down the next Figure of your *Dividend*, and ask how oft your *Divisor* may be found in the remainer so increased, & the answer put in the *Quotient*, and proved as before, till there be no Figures left in your *Dividend*, and so oft as the Question is repeated, so many places must be in the *Quotient*, as is manifest by the following Example.

1	047	) 1862798 (39634
2	094	141
3	141	452
4	188	423
5	235	297
6	282	282
7	329	159
8	376	141
9	423	188
		188
		9

Let

Let 1862798, be given to be divided by 47, I ask how often 47 may be had in 186? the Answer is 3, which I place in the *Quotient*, then I Multiply 47 by 3, the Product is 141, which being Subtracted from 186, the Remainer is 45, to which draw down 2 the next Figure in the *Dividend*, and then it will be 452, now then I ask how often 47 may be had in 452? the which by the Table made by the continual Addition of 47 unto it self, is 9 times, therefore I place 9 in the *Quotient*, and the Product of 47 is 423, which being Subtracted from 452, the Remainer is 29, to which I draw 7 the next Figure, and then proceed as before, and so at last I find the *Quotient* to be 39634.

26. *Multiplication* and *Division*, prove one another, for if you Multiply the *Quotient* by the *Divisor*, the Product will be equal to the *Dividend*: so 39634, being Multiplied by 47, the Product is 1862798, and this Product being Divided by 47, the *Quotient* is 39634.

CHAP. II.

Of Single Arithmetick in Fractions.

1. *Single Arithmetick* in whole Numbers, hath been shewed in the last Chapter; *Single Arithmetick* in Fractions now followeth.

2. A *Fraction* is a part of an Integer.

3. *Single Arithmetick* in Fractions, doth also consist of two Parts, *Notation*, and *Numeration*.

4. *Notation* of Fractions, is that which sheweth how the Fraction part of any Integer may be expressed in numbers; that is, an Integer or one whole thing being Divided into any Number of equal parts, Notation sheweth how these parts may be expressed; as if a Yard were Divided into four parts, and it were desired, that I should set down three of these parts; the usual manner is thus, draw a line, & set the Number of parts into which the Integer is supposed to be divided, under the line, and the Number of parts you would express set above the line; thus to express three of four parts, I write 4 under a line, and 3 above it, thus, $\frac{3}{4}$; and so may you do with any other number propounded: Where note, that the number above the line is called the Numerator, and the number under the line the Denominator.

5. A *Fraction* is either *Proper* or *Improper*.

6. A

6. A *Proper Fraction* is that whose Numerator is less than the Denominator, such as are these $\frac{1}{4}$ $\frac{5}{12}$ $\frac{21}{100}$.

7. A *Proper Fraction* is either *single* or *compound*.

8. A *Single Fraction* is that which consists of one Numerator and one Denominator, such as are $\frac{1}{4}$ $\frac{5}{12}$ $\frac{21}{100}$.

9. A *Compound Fraction* (otherwise called a *Fraction of a Fraction*) is that which hath more Numerators and more Denominators than one, which kind of Fractions are discoverable by this word (*of*) which is interposed between their parts; as, $\frac{2}{3}$ of $\frac{3}{4}$ is a Fraction of a Fraction, or a Compound Fraction, and expresseth two thirds of three fourths of an Integer.

10. The things expressed by broken numbers or Fractions, are principally the Parts or Fractions of Money, Weight, Measure, Time, and things accounted by the Dozen.

11. The least part or Fraction of Money used in *England* is a Farthing; and four Farthings makes a Peny; twelve Pence, a Shilling; and twenty Shillings, one Pound Sterling.

12. The least Fraction of weight used in *England*, is a Grain; that is, the weight of a Grain of Wheat, well dryed and gather'd out of the middle of the Ear, whereof 32 make a peny weight, and twenty peny weight an ounce *Troy*, and twelve ounces a Pound; but

a peny weight being thus ascertained, it is now subdivided into twenty four Grains.

13. The weights used by *Apothecaries* are derived from a Pound *Troy*, which is subdivided in this manner.

℔	A Pound *Troy*, is	12 Ounces.
℥	An Ounce, is	8 Drams.
ʒ	A Dram, is	3 Scruples.
℈	A Scruple, is	20 Grains.

14. Besides *Troy* weight, there is another kind of weight used in *England*, called *Averdupois* weight, a Pound whereof is equal to fourteen Ounces, twelve peny weight *Troy*, the which is subdivided into 16 Ounces, each Ounce into 16 Drams, and each Dram into 4 Quarters. Of this weight 112 makes a Hundred.

15. The Measures used in *England* are of Capacity or Length.

16. The Measures of Capacity are liquid or dry; Liquid Measures are according to this Table.

One

One pound of Wheat *Troy* weight ——	One Pint.
Two Pints	One Quart.
Two Quarts	One Pottle.
Two Pottles	One Gallon.
Eight Gallons	One Firkin of Ale.
Nine Gallons	One Firkin of Beer.
Two Firkins	One Kilderkin.
Two Kilderkins	One Barrel.
Forty two Gallons	One Tearce of wine
Sixty three Gallons	One Hogshead.
Two Hogsheads	One Pipe or But
Two Pipes	One Tun.

17. Dry Measures are those in which all kind of dry substances are Meted; as Grain, Sea-coal, Salt, and the like; their Table is this that followeth.

One Pint	Makes	One Pint.
Two Pints		One Quart.
Two Quarts		One Pottle.
Two Pottles		One Gallon.
Two Gallons		One Peck.
Four Pecks		1 Bushel land measure.
Five Pecks		1 Bushel water measure.
Eight Bushels		One Quarter.
Four Quarters		One Chaldron.
Five Quarters		One Wey.

18. Long Measures are expressed in the Table following.

Three Barley-corns in length	Make	One Inch.
Twelve Inches		One Foot.
Three Foot		One Yard.
Three Foot 9 Inches		One Ell.
Six Foot		One Fathom.
Five yards & a half		One pole or pearch.
Forty Poles		One Furlong.
Eight Furlongs		One *English* Mile.

Note that a Yard, as also an Ell is usually subdivided into four quarters, and each quarter into four Nails.

19. A Table of Time is this that followeth.

Sixty Minutes	Make	One Hour.
Twenty four hours		One Day natural.
Seven Days		One Week.
Four Weeks		1 month of 28 days

Fifty two Weeks, one Day, and six hours make one Year.

And these Fractions of Money, Weight, Measure, &c. are usually written under their several Denominations, instead of having their Denominators written under them thus;

lib.	*shill.*	*pence.*	*farth.*
23.	19.	08.	3.

And

And as their Notation is two-fold, so is their Numeration also; First, then I will shew you the Numeration of parts when written, as Integers, and then as vulgar fractions.

20. Numeration of parts when written, as Integers, is Accidental or Essential.

21. *Accidental Numeration*, otherwise called *Reduction*, is either descending or ascending.

22. *Reduction Descending*, is when a number of greater Denomination being given, it is required, to find how many of a lesser denomination, are equal in value to that given Number of the greater. And this is performed by *Multiplication*; as if it were required to Reduce 329 Shillings into Pence, if you Multiply 329 by 20, the number of shillings in a pound, the Product will be 6580 shillings, and 6580 shillings being multiplied by 12, the number of pence in a shilling, the Product will be 78960 pence.

23. *Reduction Ascending*, is when a number of a lesser Denomination being given, it is required, to find how many of a greater Denomination, are equal to that given number of the lesser: And this is done by *Division*; as if it were required to find how many Pounds there were in 78960 pence; if 78960 pence be divided by 12, the number of pence in a shilling, the Quotient will be 6580 Shillings, and if 6580 shillings be divi-

ded by 20, the number of shillings in a pound, the Quotient will be 329 Pounds, and so for any other.

24. *Essential Numeration*, doth consist of four Species, *Addition*, *Subtraction*, *Multiplication*, and *Division*.

25. In *Addition* of Numbers of several Denominations, you must begin with the least first, and when the sum of any of the Denominations amounts to an Integer, add it to the next Denomination that is greater.

Example.

23 : 14 : 10 : 1	15 : 18 : 10
16 : 15 : 09 : 2	16 : 17 : 09
27 : 09 : 11 : 1	17 : 16 : 08
44 : 19 : 07 : 3	18 : 15 : 07
113 : 00 : 02 : 3	69 : 08 : 10

26. In *Subtraction* of Numbers of several Denominations, when any of the parts of the greater Number are less than the parts of the lesser Number subscribed, Deduct the parts of the lesser Number from the parts of the greater, increased with an Integer, of the next superiour Denomination, and keeping one in mind, add to the next place of the number given to be *Subtracted*.

Example.

Example.

44 : 13 : 07 : 1	69 : 08 : 07
25 : 19 : 11 : 3	42 : 19 : 11
18 : 13 : 07 : 2	26 : 08 : 08

27. In *Multiplication* of numbers of several Denominations, you must first reduce the numbers given to their least Denominations and then Multiply them as hath been shewed in whole numbers, the Product divided by the square of the parts of an Integer, reduced to the least Denomination, shall in the Quotient give the Product required.

Example.

Let the Product of 17 *l.* 19 *s.* 6 *d.* by 5 *l.* 13 *s.* 6 *d.* be required. 17 *l.* 19 *s.* 6 *d.* being reduced to make 4314 *Pence.* And 5 *l.* 13 *s.* 6 *d.* reduced do make 1362 *Pence.*

The Multiplicand.	4314
The Multiplicator.	1362
	8628
	25882
	12942
	4314
The Product.	5875668

The number of pence in a pound are 240, and the ſquare thereof is 57600, by which dividing 5875668 the Quotient; 102 *lib.* 00 *ſhill.* 01 *peny.* 3 *farthings*, and $\frac{1332}{57600}$ is the Quotient ſought.

28. In *Diviſion* of numbers of ſeveral Denominations, firſt reduce your Diviſor to its number of parts in the leaſt Denomination, then Multiply your Dividend, by the ſquare of the parts in an Integer reduced to the leaſt Denomination; & if there be any parts entered, to the Integers of the Dividend, they muſt be reduced to the higheſt Fraction, that the ſquare of the parts in an Integer reduced to its leaſt denomination will bear, and added to the former Product, the whole being divided by your diviſor reduced, will give you the Quotient ſought.

Example.

Let 102 : 00 : 01 : 3 $\frac{1332}{57600}$ be given to be divided by 5 : 13 : 6. Firſt I reduce the diviſor given to its number of parts in the leaſt denomination, and it makes 1362 pence, then I Multiply 102 the Integral part of my dividend, by 57600, the ſquare of pence in a pound, the Product is 58752, and the Fraction of my dividend 00 : 01 : 3 $\frac{1332}{57600}$ being reduced, is $\frac{1332}{57600}$, which being added to the former Product 58752, the ſum is 5875668, for the dividend; which being divided by

1362,

1362, the Quotient is 4314 *pence*, that is 17 *lib.* 19 *shill.* 6 *pence.*

29. *Numeration* of Fractions, when written with their Numerators and Denominators, is also Accidental and Essential.

30. *Accidental Numeration*, otherwise called *Reduction*, is three-fold.

1. To Reduce one Fraction which is not already in its least terms, to a lesser denomination.

To do this, divide the numerator and denominator by their greatest common measure, the two Quotients shall be one of them, a new numerator, and the other a new denominator of a Fraction equal to the Fraction given, and in its least terms.

Example $\frac{91}{117}$ being given to be Reduced, the greatest common measure is 13, by which dividing 91, the Quotient is 7, for a new numerator, and dividing 117 by 13, the Quotient is 9 for a new denominator, and so $\frac{91}{117}$ is reduced to $\frac{7}{9}$.

The greatest common measure between two numbers is found thus; divide the greater number by the less, and your divisor by the Remainer, if there be any, your last divisor is the common measure sought, as in the following Example.

91) 117 (1
91
---
26) 91 (3
78
---
13) 26 (2
26

0

2. To Reduce many Fractions of divers Denominations into one Denomination.

To do this, Multiply each Numerator by all the Denominators except its own, the Products shall be the new Numerators, then Multiply all the Denominators together, and the Product shall be the common Denominator sought.

Example. $\frac{2}{3}$ $\frac{4}{5}$ $\frac{6}{7}$ will be reduced to $\frac{14}{105}$ $\frac{24}{105}$ $\frac{20}{105}$.

3 To Reduce any Fraction from one Denomination, to any other Denomination desired. And to do this Multiply the Numerator given, by the Denominator required, & divide the Product by the Denominator given, the Quotient shall be the Numerator desired.

Example, let it be desired to Reduce $\frac{17}{20}$ to a Fraction, whose Denominator shall be 100, first Multiply 17 by 100, the Product is 1700 which being divided by 20, the Quotient is

85,

85, for the new Numerator desired.

31. Essential Numeration of Fractions hath four Species, *Addition*, *Subdultion*, *Multiplication* and *Division*.

32. In Addition of Fractions, the Fractions given must be first Reduced to one Denomination, and then add the Numerators together, so have you the Sum of the Fraction, so $\frac{2}{9}$ and $\frac{1}{9}$ make $\frac{3}{9}$.

33. Subtraction of Fractions is thus, if of one Denomination, deduct the less from the greater, their difference is the remainer, so $\frac{2}{9}$ taken from $\frac{3}{9}$ rest $\frac{1}{9}$.

34. Multiplication of Fractions, is thus, Multiply all the Numerators together, so is their Product a new Numerator, then Multiply all the Denominators together, and their Product is a new Denominator.

Thus if $\frac{3}{12}$ and $\frac{1}{8}$ were to be Multiplied, the Product will be $\frac{3}{96}$.

35. *Division* of Fractions is thus, Multiply the Numerator of the dividend by the denominator of the divisor, the Product shall be a new Numerator; also Multiply the numerator of the divisor, by the denominator of the dividend, so shall the Product be a new denominator, and this new Fraction is the quotient sought; so if $\frac{3}{9}$ were to be divided by $\frac{1}{3}$, the Product will be $\frac{30}{27}$.

36. When the denominator of a Fraction is an Unite with Cyphers, the Fraction is more particularly called a *Decimal*; and

such Fractions may be expressed without their denominators as well as with them, thus, $\frac{5}{10}$ may be written thus, ,5.

37. When the Numerator doth not consist of so many places, as the denominator hath Cyphers, fill up the void places of the Numerator with Cyphers, so, $\frac{5}{100}$, $\frac{25}{1000}$, are written thus, ,05, and ,025.

38. Numeration of *Decimal-Fractions*, is likewise two-fold, Accidental and Essential.

39. Accidental Numeration, otherwise called Reduction, is performed, by the third way of Reduction; shewed in the Twenty seventh Rule of this chapter.

40. Essential Numeration, hath in it the four usual Species, *Addition*, *Subtraction*, *Multiplication*, and *Division*.

41. Addition of Decimals is the same with Addition of whole Numbers, if a point or line be set between the Integers and the Parts, as in the following Examples.

2.00741	23.05678
.74258	16.14365
.96314	32.76108
3.71313	71.96151

42. Subduction of Decimals doth differ from Subduction in whole Numbers, but by a point to distinguish the whole number from the broken; as in the Example following.

25.

25.07496	36.01436
17.89637	17.83589
7.17859	18.17847

43. *Multiplication* of *Decimal Fractions*, is the same with *Multiplication* in whole numbers, but when the work is finished, to distinguish the *Integers* from the *Decimals*, do thus; so many places of parts as are in both the numbers given, being separated by a point, the rest of the figures towards the left hand are Integers, and those towards the right are *Decimal* parts; as in these Examples.

12.45	17.37
7.08	3.72
9960	3474
87150	12159
	5211
88.1460	64.6164

44. Division of Decimal Fractions is the same with Division in whole numbers, but when the Work is finished, to distinguish the Fractional part from the Integers, observe this general Rule.

The

The first figure in your quotient will be always of the same degree or place with that Figure or Cypher in your dividend, which standeth over the Unites place in your divisor.

For Example: 78925, being given to be divided by 32, the quotient will be 2466,& because the place of Unites in the divisor, doth stand under the place of seconds in the dividend, therefore the first figure in the quotient, will be in the place of seconds, and the first must be supplied with a Cypher, and then the quotient will be 0.02466.

CHAP. III.

Of Comparative Arithmetick.

THus much hath been said concerning *Single Arithmetick*, *Comparative* follows, which is wrought by Numbers, as they are considered to have relation to one another.

2. This Relation consists either in quantity or in quality.

3. Relation in quantity is the reference that the Numbers themselves have one to another; as when the comparison is made between 8 and 2, or 2 and 8; 7 and 3, or 3 and 7.

And

And here the Numbers propounded are always two, whereof the first is called the Antecedent, the other the Consequent.

4. Relation in quantity, consists either in the difference, or in the rate or reason found between the Numbers propounded; the one is found by Subtracting the less from the greater; so 6 is the difference between 8 and 2; but the other, to wit, the rate or reason, is found by dividing the greater by the less, and thus the rate between 8 and 2 is four-fold, because 2 is found four times in 8; Or the rate may be also found by dividing the less by the greater, or setting the Numbers given in manner of a Fraction, and thus the rate between 2 and 8 is 4 also, or $\frac{2}{8}$ that is $\frac{1}{4}$.

5. This rate or reason of Numbers is either equal or unequal; equal reason, is the relation that equal Numbers have one to another, as 5 to 5, 6 to 6. Unequal Reason is the relation that Unequal Numbers have one to another, and this is either of the greater to the less, or of the less unto the greater.

In the one the greater Number is the Antecedent, and the less the Consequent; and in the other the lesser Number is the Antecedent, and the greater is the Consequent.

6. Relation in quality, (otherwise called Proportion) is the reference or respect that the reasons of Numbers have one to another

ther, and therefore the Numbers must be more than two, or else three cannot be the comparing of reasons in the Plural Number.

7. *Proportion* is two-fold, *Arithmetical* and *Geometrical*.

8. *Arithmetical Proportion*, is when numbers differ according to equal reason; that is, have equal differences; as, 2, 4, 6, 8, 10, or 3, 6, 9, 12, in the first rank the common difference is 2, and in the second 3.

9. *Arithmetical Proportion*, is either continued, or interrupted.

10. *Arithmetical Proportion* continued, is when divers numbers are linked together by a continued *Progression* of equal difference; and in such a *Progression*, the sum of the first and last Terms being Multiplied by half the number of the Terms, the Product will be the sum of all the Terms; as in this *Progression*, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, the sum of the first and last is 13, which being Multiplied by 6, half the number of the Terms the Product is 78, the sum of all the Terms in that *Progression*.

11. Three Numbers being given in *Arithmetical Proportion*, the mean number being doubled is equal to the sum of the Extreams; so 3, 6, 9, being given, the double of 6, the mean number is equal to the sum of 3 and 9, the two Extreams.

12. *Arithmetical Proportion* Interrupted, is when the *Progression* is discontinued,

as

as in these numbers, 2, 4, 8. 10.

13. In *Arithmetical Proportion* continued, or discontinued, the sum of the Means is equal to the sum of the Extreams, as in 3, 6, 9, 12, being given, the sum of 6 and 9 is equal to the sum of 3 and 12; or 3, 6, 12, 15, being given, the sum of 6 and 12, is equal to the sum of 3 and 15.

14. *Geometrical Proportion* is, when divers numbers differ by the like reason; as, 1, 2, 4, 8, 16, which differ one from another by double reason; for as 1 is the half of 2, so 2 is the half of 4, 4 of 8, 8 of 16.

15. *Geometrical Proportion* is either continued or interrupted, *Geometrical Proportion* continued, is when divers numbers are linked together, by a continued Progression of the like reason; as, 1, 2, 4, 8, 16, or 3, 6, 12, 24, 48.

16. In Numbers *Geometrically* proportional, If you Multiply the last Term by the common rate by which they differ, and from the Product deduct the first Term, and divide the Remainer by the former rate less by an Unite, the Quotient shall be the sum of all the Progressions; So 2, 6, 18, 54, 162, 486, 1458, being propounded the last term 1460, being multiplied by 3 the rate, the Product is 4374 out of which deducting 2 the first Term, the Remainer is 4372, which being divided by 2 the rate less one, the quotient 2186 is the sum of that Progression.

17. Three

17. Three Proportionals being given, the ſquare of the Mean is equal to the Product of the Extreams; ſo 4, 8, 16, being given, the ſquare of 8 is equal to four times 16.

18. *Geometrical Proportion* interrupted, is when the Progreſſion of like reaſon is diſcontinued; as, 2, 4, 16, 32, where the Term between 4 and 16 is wanting, and therefore the rate between 4 and 16 is not the ſame that is between 2 and 4, or 16 and 32.

19. Four Proportional Numbers whatſoever being given, the Product of the two Means is equal to the Product of the two Extreams; ſo 2, 4, 16, 32, being propounded, 4 times 16 is equal to 2 times 32, which is 64.

CHAP. IV.

Of the Rule of Proportion, or Rule of Three.

FRom the laſt Rule of the former Chapter ariſeth that precious Gem in Arithmetick, the *Rule of three*, which for its excellency, deſerves the name that is given to it, *The Golden Rule*.

2. *The*

2. *The Golden Rule*, is that by which certain numbers being given, another number Geometrically proportional to them may be found out.

3. The *Golden Rule* is either single or compound.

4. The single Rule, is when three terms or numbers are propounded, and a fourth in proportion to them is desired.

5. The Terms of the Rule of Three consist of two Denominations; two of the Terms propounded have one Denomination, the third propounded and fourth required, have another.

6. Of those two numbers given which are of one Denomination, that which mates the Question must possess the third place, the other number of the same Denomination, must be put in the first place, and consequently, the other known Term, which is of the same Denomination with the fourth required, must possess the second place.

7. The three Terms propounded being thus placed, consider whether your third doth require more or less; if it requires more, Multiply the middle number by the greater of the two Extreams, and divide the Product by the lesser, the Quotient is the fourth Number or Term desired.

But if the third Term in the Question require less, Multiply the middle Term by the lesser of the two Extreams, and the Pro-

duct Divide by the greater, the Quotient shall be the fourth Term desired; An Example in each Case will sufficiently explain the Rule.

If 7 Pound of Sugar cost 2 *s.* 7 *d.* What shall 28 Pound of Sugar cost? The Terms must stand thus,

lb *Sugar.*	*s.*	*d.*	lb *Sugar.*
7	2	7	28

Where it is plain, that 28 pound of Sugar must needs cost more than 7, therefore I Multiply 2 *s.* 7 *d.* or 31 *pence*, by 28, the Product 868 being Divided by 7, and the Quotient is 124 *d.* or 10 *s.* 4 *d.*

2. *Example*: If 7 Men will digg a Garden in 31 Dayes, In how many Dayes will 28 Men digg the same Garden? Here the Terms must stand thus,

Men.	*Dayes.*	*Men.*
7	31	28.

And by the state of the Question it plainly appears, that the third Term requireth less: therefore I Multiply 31, the middle Term, by 7, the lesser Extream, and the Product 217 being Divided by 28, the Quotient $7\frac{1}{28}$ is the fourth Term desired.

CHAP.

CHAP. V.

Of the Compound Rule of Three.

THe *Compound Rule of Three*, is when more than three Terms are propounded.

2. Under the *Compound Rule of Three* is comprehended the *Double Rule of Three*, and divers Rules of plural proportion.

3. The *Double Rule of Three*, is when five Terms are propounded, and a sixth in proportion to them is required.

4. In this Rule the five Terms given do consist of two parts; first a Supposition, and then a Demand; the Supposition is expressed by three of the Terms propounded, and the demand by the other two.

5. And here the greatest difficulty is in placing of the Terms; for which observe amongst the Terms of Supposition, which of them hath the same Denomination with the Term required, reserve that for the second place, and write the other two Terms in the Supposition one above another in the first place; and lastly, the Terms of Demand one above another, likewise in the third place, in such sort, that the uppermost may have the same denomination with the uppermost of those in the first place.

Example.

If 6 Clerks can write 45 sheets of Paper in 5 Dayes; How many Clerks can write 300 sheets in 72 Dayes? Here the Question is concerning the number of Clerks, the 6 Clerks must therefore possess the second place, and the Dayes and Paper in the Supposition must be set in the first, one over the other, of which, if Paper be the uppermost in the other Terms, the Paper must be set over the Dayes in the third place, and then the Number in the Question will stand thus,

45 —— 6 —— 300
5 13

6. The Terms propounded being thus placed, the Question may be resolved by two Single Rules of Three in this manner.

1. As the uppermost Term of the first place is to the middle, so is the uppermost Term in the last place to a fourth Number.

2. As the lower Term of the first place is to that fourth Number, so is the lower Term of the last place to the Term required.

But in both these Proportions, consideration must be had to the Term required, namely, whether it must be more or less than the middle Term *given*.

In

In our present Question, the fourth term in the first proportion must be greater than the second; for it is plain, that more work will require more men; therefore I say,

as 45 . 6 :: 300 . 40 Clerks.

But in the second proportion, it is likewise plain, that the more time is given, the fewer persons are required; and therefore in this proportion, 5. 40. 13. I multiply the middle term by the first, and the product 200 I divide by 13, the last, and the Quotient is 15 $\frac{5}{13}$.

2. *Example*: If 100 *l.* gain 6 *l.* in 12 months, what shall 276 *l.* gain in 18 months? In this Question the terms must be thus placed.

100 —— 6 —— 276
12 18

1. 100 . 6 :: 276 . 16 . 56.

2. 12 . 16 . 56 :: 18 . 24 . 84.

CHAP. VI.

Of the Rule of Fellowſhip.

THe Rules of plural proportion are thoſe, by which we Reſolve Queſtions that are diſcoverable by more Rules of Three than one, and cannot be performed by the double *Rule of Three* mentioned in the laſt chapter.

Of theſe Rules there are divers kinds and varieties, according to the nature of the Queſtion propounded; I will only mention one, and refer the reſt to my larger treatiſe of this Subject.

2. The Rule of plural proportion that I mean to mention, is the Rule of *Fellowſhip*.

3. And the Rule of *Fellowſhip* is that by which in Accompts amongſt divers Men, (their ſeveral ſtocks together) the whole Loſs or Gain being propounded, the Loſs or Gain of each particular man may be diſcovered.

4. The *Rule of Fellowſhip* is either ſingle or double.

5. The *Single Rule of Fellowſhip* is, when the ſtocks propounded are ſingle numbers; As in this Example: *A* and *B* were Partners in an Adventure to *Sea*, *A* put in 25 *l.* *B* 56, and upon return of the Ship, they ſold the

Fraight

Fraight for 50 *l.* profit; the queſtion is, What part of this 50 *l.* is due to *A*, and what to *B*? to reſolve this and the like Queſtions, the ſum of the ſtocks muſt be the firſt term in the Rule of Three, the whole gain the ſecond, and each particular ſtock the third; this done, repeating the Rule of Three, as often as there are particular ſtocks in the Queſtion, the fourth term produced by theſe ſeveral operations are the reſpective Gains or Loſſes of thoſe particular ſtocks propounded; ſo in the preſent queſtion, the Reſolution will be as here you ſee.

81 . 50 :: $\left.\begin{matrix} 25 \\ 56 \end{matrix}\right\}$ 15 . 432.
34 . 567.

6. The *Double Rule of Fellowſhip* is, when the ſtocks propounded are double numbers, that is, when each ſtock hath relation to a particular time. *A*, *B*, and *C*, hire a piece of Ground for 45 *l. per Annum*, in which *A* had 24 Oxen 32 days, *B* 12, for 48 days, *C* 16, for 24 days; now the queſtion to be reſolved is, What part of the Rent each perſon muſt pay?

For this purpoſe you muſt firſt Multiply each particular ſtock by its reſpective time, and take the total of their Products for the firſt term, the Gain or Loſs for the ſecond, and every man's particular ſtock and time

for the third; this done repeating the Rule of Three so often as there are Products of the double Numbers; the fourth terms produced upon those several operations are the numbers sought. So then in the question propounded, the Product of 24 and 32 is 768; the Product of 12 and 48 is 576, and the Product of 16 and 24 is 384, the sum of these Products is 1728, which is the first term, 45 *l.* the Rent is the second, and each particular Product the third;

$$1728 . 45 :: \begin{cases} 768 . 20. \\ 576 . 15. \\ 384 . 10. \end{cases}$$

By which thret Operations the question is Resolved.

FINIS.

THE *ENGLISH* ACADEMY.

The THIRD PART.

Of GEOMETRY.

CHAP. I.

Of the Definition and Division of Geometry.

GEOMETRY is the Art of Measuring well.

2. The Subject of *Geometry* is Magnitude, or continued Quantity, whose parts are joyned together by a common term or limit.

3. *Magnitude* is either a Line, or something made of a Line or Lines.

4. A *Line* is a Magnitude, consisting only of length, without either breadth or thickness, the term or limit whereof is a Point.

5. A *Point*, is an indivisible sign in Magnitude. A *Point* therefore is no quantity, but the beginning of all continued quantities, which are divisible in power infinitely.

6. A *Line* is either considered simply by it self, or else comparatively with another Line.

7. A *Line* considered simply of it self, is either Right or Oblique.

8. A *Right line*, is that which lyeth equally between his Points.

9. An *Oblique line*, is either circular or mixt.

10. A *Periphery*, or Circular Line, is that which is equally distant from the middle of the comprehended space, which middle is called the *Centre*, and the distance between that Centre and the Circumference, is called the *Radius*.

11. Lines compared to one another are of the same or different Species.

12. Lines compared together of the same Species, are either Parallel or Angular.

13. *Parallel lines*, are such as are equally distant in all places, and are either Right lined Parallels, or Circular.

14. *Right lined Parallels*, are such as being in one and the self same plane, and infinitely produced on both sides, do never meet in any part.

15. A *Circular Parallel* is a Circle drawn within or without another Circle.

16. *Angular*

16. *Angular lines* are such as inclining, or bowing to one another, touch one another, but not in a direct line.

17. An *Angle* is either Right or Oblique.

18. A *Right Angle*, is that whose legs or sides are Perpendicular to one another.

19. An *Oblique Angle*, is that whose legs or sides do incline to one another upon one side more than upon another.

20. An *Oblique Angle* is either Acute, or Obtuse.

21. An *Acute Oblique Angle*, is that which is less than a Right.

22. An *Obtuse Oblique Angle*, is that which is greater than a Right Angle.

23. The *Measure of an Angle*, is the Arch of a Circle described upon the Angular Point, and intersected between the sides of the Angle sufficiently prolonged; but of this Measure there can be no certain knowledge, unless the quantity of that Arch be expressed in Numbers.

24. Every Circle therefore is supposed to be divided into 360 equal parts, called Degrees, and every Degree into 60 Minutes, and every Minute into 60 Seconds, and so forward; others suppose every Degree to be subdivided into 10 parts, and every one of those into 10 more, and so forward, as far as you please.

25. A *Semi-circle* is the half of a whole Circle, and containeth 180 Degrees.

26. A *Quadrant*, or fourth part of a Circle, is 90 Degrees; and seeing that a Right Line falling Perpendicularly upon a Right Line, doth make the Angles on both sides equal, and cutteth a Semi-circle into two equal parts, the fourth part of a Circle, or 90 Degrees, must needs be the Measure of a Right Angle.

27. Thus are Lines compared with Lines of the same Species, the comparing of Lines of different Species, is the comparing of Right Lines with those that are Oblique or Circular.

28. And *Right Lines*, as they have reference to, or are compared with the circumference of a Circle, are either such as are inscribed within it, or applyed to it.

29. A *Right Line*, inscribed in a Circle, either passeth through the Centre, as the Diameter and Radius, or is drawn besides the Centre, as Chords and Sines.

30. A *Diameter*, is a Right Line inscribed through the Centre of the Circle, dividing the Circle into two equal parts.

31. The *Radius* of a Circle is the one half of the Diameter, or a Right Line drawn from the Centre to the Circumference; thus the Right Line *G B D*, in *Fig.* 1. is a Diameter, *G B*, or *B D*, the Radius.

32. A *Chord* or *Subtense*, is an inscribed Right Line drawn through or besides the Centre bounded at both ends with the Circumference.

33. A *Chord* or *Subtense*, drawn through the Centre is the same with the Diameter.

34. A *Chord* or *Subtense*, drawn besides the Centre, is a Right Line bounded at both ends with the Circumference, but always less than the Diameter.

35. *Sines* are either Right or Versed.

36. A *Right Sine* is half the Chord of the Double Arch, and it is either the whole *Sine*, and *Sine* of 90 Deg. or *Sine* less than the whole.

37. The whole *Sine* is equal to the *Semidiameter* or Radius of a Circle, as the right Line *B E*.

38. A Sine less than whole, is half the Chord of any Arch less than a Semi-circle, as *C A* is the Sine of *C D*.

39. A *Versed Sine*, is a part of the Diameter lying between the right line and the circumference, as the Right Line *A D*, which is one part of the Diameter, is the versed line of the Arch *C D*, and the right line *A G*, which is the other part of the Diameter, is the versed line of the Arch *C E G*.

40. A *Right line* applied to a Circle, is either a Tangent or Secant.

41. A *Tangent*, is a right line without but touching the Circle, drawn Perpendicular to the end of the Radius or Diameter, continued to the Secant.

42. A *Secant*, is a right line drawn from the Centre of the Circle, through the term

of an Arch, and continued to the Tengant; thus the right line *F D*, is the Tangent, and the right line *B F*, is the Secant of the Arch *C D*, or of the Arch *C E G*, the Complement thereof to a Semi-circle.

43. These Lines thus inscribed in, or applyed to a Circle, may to any limited Radius be drawn or made upon a Rule of Wood, Brass, or other Metal; or a Table may be made, expressing the length of these lines in numbers, answering to every Degree and part of a Degree in the Quadrant or Semicircle: That is, the lines of *Chords* and *Versed Sines* may be made to any part of a *Semicircle*, and the lines of *Sines*, *Tangents* and *Secants*, to any part of a Quadrant. The use of such Scales and Tables is such, that no Student in *Geometrie* can well be without them; here therefore I will lay down such Propositions as will sufficiently demonstrate the way of making these lines upon a Scale or Ruler, but as to the construction of the Tables by which the lengths of these lines are expressed in Numbers; I refer them to my *Trigonometria Britannica*, and other Books of the like nature.

Proposition I.

Upon a Right Line given, to erect a Perpendicular, from any Point assigned.

Let it be required to erect a Perpendicular to the line *D G*, from the Point *B*, in *Fig.* 2. take two equidistant Points, as *D* and *G*, open your Compasses to a convenient distance, and letting one Foot of your Compasses in *B*, draw the Arch *E C*, and keeping your Compasses at the same distance, set one Foot in *G*, and with the other draw the Arch *H I F*, and through the Intersections of these two Arches draw a right line, as *B L*, which shall be perpendicular to the Point *B*.

But if it were required to erect a Perpendicular from the end of a line, do thus, your Compasses being opened to any convenient distance, set one Foot in the Point given, as at *A*, in the line *A B*, and the other at *D*, or where you please, and making *D* the Centre, draw the Arch *C A E*, and from the points *C* and *D*, draw the right line *C D E*, then draw the line *A C*, which shall be Perpendicular to the line *A B*, from the point *A*, as was required.

Proposition II.

From a Point assigned without a Right Line given, to let fall a Perpendicular.

Let the given line be *D G*, and let the point assigned be *L*, at the distance of *L D* draw the Arch *D A G F*, then setting one Foot of your Compasses in *D*, draw the Arch *J K*, and keeping your Compasses at the same distance, set one Foot in *G*, and with the other draw the Arch *M*, the right line *L E D* drawn through the Intersections of those two Arches shall be Perpendicular to *D G*, from the Point *L*, as was required.

But if it were required to let fall a Perpendicular from the point *E*, upon the line *A B*, draw the line *E D C* at pleasure, which being bisected at *D*, upon *D* as a Centre at the distance of *E D*, draw the Arch *E A C*, so shall the line *E A* be perpendicular to *A B*, as was required.

Proposition III.

To Divide a Right Line given into any number of equal parts.

Draw the line *A C*, and from the points *A* and *C* erect the Perpendiculars *A E* and *X C*, and at any distance of the Compasses, set

set off as many equal parts as you please upon the Perpendiculars *A E*, and *X C*, and draw the Parallel lines *E X*, *F V*, *G T*, *H S*, *K R*, *L Q*, *M P*, and *N O*; and let it be required to divide the right line into three equal parts, open your Compasses to the length of the line given, and setting one foot in *A*, where the other foot shall touch the third Parallel, make a mark which is at *Z*, draw the line *A Z*, so shall the line *A Z* be divided into three equal parts, as was desired.

And thus may that line be made, which is commonly called the *Diagonal Scale*.

Proposition IV.

How to divide a Circle into 120 *Parts, and by consequence into* 360.

Draw the Diameter *B C*, and upon the point *A*, describe the Circle *C D B L*, then draw the Diameter *D A N*, at Right Angles, to the Diameter *C A B*.

2. The *Semidiameter* or Radius of a Circle will divide the Circle into 6 equal parts, and so is equal to the Chord of 60 degrees, *A C*, therefore being set from *D* to *F*, shall mark out the Arch *D F*, 60 degrees.

3. The side of a *Pentagon* or fifth part of a Circle, is 72 degrees; now then, if you bisect the Radius *A C* in the point *E*, and

make $E G = E D$, then shall $D G = D M$, the side of a *Pentagon* or Chord of 72 degrees, and $F M$ the difference between $D M$, 72 and $D F$ 60, that is the Chord of 12, which by bisection shall give the Chord of 6 and 3 degrees, and so the Circle may be divided into 120 parts, as was propounded.

4. A Circle being thus divided into 120 degrees, the Arches are so equal, that the third part of the Chord of 3 degrees will subdivide it into 36, without sensible error; and your Circle being thus divided into 360 parts, every degree, or half degree, drawn parallel to the Diameter, shall constitute the line of Chords, & half those Chords the line of sines; and the *Segments* of the Diameter, the line of versed sines, and as for the Tangents and Secants, a line touching the Circle drawn perpendicular to the end of the Diameter, and continued to the several lines drawn from the Centre, through every degree of the Quadrant, shall constitute the line of Tangents, and those lines drawn from the Center to the Tangents, shall constitute the line of Secants also. And thus may a Scale be made with the lines of *Sines, Tangents, Secants*, and equal parts.

CHAP.

CHAP. II.

Of Right Lined Triangles.

HItherto we have spoken of the first kind of *Magnitude*, that is, of Lines, as they are considered of themselves, or among themselves.

2. The second kind of Magnitude, is that which is made of *Lines*, that is a Figure.

3. A *Figure* is that which is every where bounded, whether it be with one only limit as a Circle, or with more, as a Triangle, Quadrangle, Pyramis, or Cube, &c.

4. The terms or limits of every Figure, are either *Lines* or *Superficies*.

5. A *Figure* which is terminated by *Lines* is a *Superficies*.

6. A *Figure*, which is bounded or limited with several *Superficies*, is a Body or Solid.

7. A *Superficies* is a Magnitude, consisting of length and breadth, and is either right lined, curve lined, or composed of both.

8. A *Right Lined Plane* or *Superficies*, is that which is Terminated with right lines; and it is either a Triangle, or a Triangulate.

9. A *Triangle*, or the first right lined Figure, is that which is comprehended by

three right lines. It is distinguished from the sides, or from the Angles.

10. In respect of the sides, a Triangle is either *Isopleuron*, *Isosceles*, or *Scalenum*.

An *Isopleuron Triangle*, is that which hath three equal sides. An *Isosceles*, which hath two equal sides. And a *Scalenum*, whose three sides are all unequal.

11. In respect of the Angles, a Triangle is either Right or Oblique.

12. A *Right Angled Triangle*, is that which hath one right line.

13. An *Oblique Angled plane Triangle*, is either Acute or Obtuse

14. An *Oblique and Obtuse Angled plane Triangle*, hath two Acute Angles and one Obtuse; an Acute angled Triangle hath all the three Angles Acute.

15. The second sort of right lined planes is called a *Triangulate*, or a Plane, composed of *Triangles*.

16. The sides of a Triangulate, are in number more by two than the Triangles, of which it is composed.

17. A *Triangulate*, is either a *Quadrangle*, or a *Multangle*.

18. A *Quadrangle*, is a Plane comprehended, by four right lines, and is either a *Parallelogram* or a *Trapezium*.

19. A *Parallelogram*, is a Quadrangle, whose opposite sides are Parallel or Equidistant, and it is either Right Angled or Oblique.

20. A

20. A *Right Angled Parallelogram*, is that which hath every Angle Right, and it is either a Square or an Oblong.

21. A *Square* is a Right Angled Parallelogram, whose four sides are equal, and the Angles Right.

22. An *Oblong*, is a Right Angled Parallelogram, whose Angles are all right, but the sides unequal.

23. An *Oblique angled Parallelogram*, is that whose Angles are all Oblique, and is either a *Rhombus*, or a *Rhomboides*.

24. A *Rhombus*, is an Oblique Angled Parallelogram, of equal sides.

25. A *Rhomboides*, is an Oblique angled Parallelogram of unequal sides.

26. A *Trapezium*, is a Quadrangle, but not a Parallelogram, and it is either Right angled, or Oblique.

27. A *Right Angled Trapezium*, hath two opposite sides, parallel, but unequal, and the sides between them perpendicular.

28. An *Oblique Angled Trapezium*, is a Quadrangle, but not a Parallelogram, having at least two Angles thereof Oblique, and none of the sides Parallel.

29. A *Right angled Multangled Plane*, is that which is comprehended by more than four lines.

30. A *Multangled Right lined Plane*, or *Polygon*, is either Ordinate and Regular, or Inordinate and irregular.

31. *Ordinate and Regulate Polygons*, are such as are contained by equal sides and angles, as a *Pentagon*, *Hexagon*, &c.

32. *Inordinate or Irregular Polygons*, are such as are contained by unequal sides and angles.

33. Having thus shewed what a right lined Figure is, with the several sorts of them, we will now shew, how they may be measured, both in respect of the lines by which they are bounded, and also of their Area or Superficial Content.

33. And first we will shew how the lines, and angles of all plane Figures, especially Triangles, may be measured, as being the first and chiefest of them, and into which all other may be reduced.

34. The sides of all plane Triangles, and other plane Figures, are to be Measured by the scale or line of equal Parts.

35. The Angles may be measured by the lines of Sines, Tangents, or Secants, as well as by the line of chords; but here it shall suffice to shew how any Angle may be protracted, or being protracted, be Measured by the line of Chords only.

Pro-

Propoſition I.

How to protract or lay down an Angle to any quantity or number of Degrees propoſed.

Draw a line at pleaſure at *A B*, then open your Compaſſes to the number of 60 degrees in your line of Chords, and ſetting one of that extent in *B*, with the other deſcribe the Arch *C D*, and from the point *B*, let it be required to make an Angle of 40 degrees; open your Compaſſes to that extent in the line of Choads, and ſetting one Foot in *D*, with the other make a mark as at *E*, and draw the line *E B*, ſo ſhall the Angle *A B E* contain 40 degrees, as was required.

Propoſition II.

How to find the quantity of any Angle already protracted.

Let the quantity of the Angle *A B E*, be required; open your Compaſſes in the line of Chords, from the beginning thereof to 60 degrees, and ſetting one foot thereof in the point *B*, with the other deſcribe the Arch *D F*, then take in your Compaſſes the diſtance between *E* and *D*, and applying that extent to the line of Chords, it will ſhew you the number of degrees contained

in that Angle, which in our Example will be found to be 40 degrees.

These things premised, we will now shew you how all plane Triangles may be measured, in respect of their Sides and Angles, both by the Scale, and also by the Tables of Sines and Tangents.

CHAP. III.

Of the Solution or Mensuration of plane Triangles.

IN the *Solution* of plane Triangles, the angles only being given, the sides cannot be found, but the reason of the sides only; it is therefore necessary, that one of the sides be known.

2. In all plane Triangles, the three angles are equal to two Right: two Angles therefore being given, the third is also given; and one of them being given, the sum of the other two is also given.

3. In a Right angled plane Triangle, one of the Acute Angles being given, the other is also given, it being the Complement of the other to a Quadrant or 90 degrees.

4. In a Right Angled plane Triangle, there are seven Cases, whose Solution shall be shewed in the Problems following.

5. The

5. The sides comprehending the Right angle we call the legs, and the side subtending the Right angle, we call the *Hypothenuse*.

Problem I.

The Legs given, to find an Angle and the Hipothenuse.

In the right angled plane Triangle *A B C*, let there be given the legs.

A B 512. } To find { *Hypot. B C.*
A C 384. } { *Angl. B* and *C.*

Draw a line at pleasure, as *A B*, and upon the point *A*, erect the perpendicular *A C*, and by help of your Scale of equal parts, set off from *A* to *B*, 512, and also from *A* to *C*, 384, and draw the line *B C*, for the *Hypothenuse*, which being Measured by the scale of equal Parts, will be found to be 646. and by the line of Chords, the angle at *B* 36. 87, whose complement is the angle *A C B*, 53. 13.

By the Tables, the Proportions are,

1. *A B* . *A C* :: *Radius* . *tang. B.*
2. *A B* . *A C* :: *Radius* . *B C.*

Problem II.

The Angles and one Leg given to find the Hypothenuse and the other Leg.

Draw a line at pleasure, as *A B*, and at Right angles the point *A* erect the perpendicular *A C*, and by your scale of equal parts set off from *A* to *B* 512, and upon the point *B* lay down the angle *A B C*, 36. 87. and draw the line *B E*, till it cut the perpendicular *A C*, then measure the lines *B C* and *A C*, by the scale of equal parts, so shall the one, to wit, *B C*, be the Hypothenuse, and *A C*, the other leg inquired.

By the Tables, the Proportions are,

3. *Rad.* . *A B* :: 4 *B* . *A C*.

4. *Sine C* . *A B* :: *Rad.* . *B C*.

Problem III.

The Hypothenuse and Oblique Angles given, to find the Legs.

Draw a line at pleasure, as *A B*, and upon the point *B* protract one of the angles given, suppose the lesser *A B C*, 36. 87. and draw

draw the line *B C*, & by your scale of equal parts, number the given Hypothenuse from *B* to *C* 640. and from the point *C* to the line *A B*, let fall the Perpendicular *A C*, then is *B A* one, and *C A*, the other leg inquired.

By the Tables, the Proportion is,

5. *Rad.* . *BC* :: *sB* . *AC*.

Problem IV.

The Hypothenuse and one Leg given, to find the Angles and the other Leg.

Draw a line at pleasure, as *A B*, and by your scale of equal parts, number from *B* to *A*, the quantity of the given leg *A B*, 512. then upon the point *A* erect the Perpendicular *A C*, and opening your Compasses to the extent of your Hypothenuse *B C* 640, set one Foot in *B*, and move the other, till it touch the Perpendicular *A C*, and there draw *B C*, so shall *A C* be the leg inquired, and either Angle may be found by the line of Chords.

By the Tables, the Proportions are,

6. *BC . Rad. :: AB . Sine C.*

7. *Rad. . BC :: Sine B . AC.*

6. Hitherto we have ſpoken of Right angled plane Triangles, the Problems following concern ſuch as are Oblique.

Problem V.

The angles in an Oblique angled plane triangle one ſide given, to find the other ſides.

In the Oblique angled plane Triangle *BCD*, let there be given the ſide *CB* 632, and the Angles *DCB* 11. 07. *D*. 26. 37.

Draw the line *CB* at pleaſure, and by your ſcale ſet off from *C* to *B* 632, and upon thoſe points protract the given Angles *DCB* 11. 07 *CBD*. 142. 56, and draw the lines *CD* and *BD*, till they interſect one another, then ſhall the one ſide be *CD* 865, and the other *DB* 273.

By the Tables, the Proportion is,

1. *Sine BDC . BC :: Sine DCB . DB.*

Problem VI.

Two sides of an Angle opposite to one of them being given, to find the other Angles and the third side, if it be known whether the Angle opposite to the other given side be Acute or Obtuse.

In the Oblique angled plane Triangle *B C D*, let there be given,

The Sides { *C B* 632 } { *Ang. D.* 28. 37.
{ *C D* 865 }

Draw the line *C D* at pleasure, and by your scale set off from *C* to *D*, 865, and upon the point *D* protract the Angle *C D B* 28. 37. and draw the line *D B*, then open your Compasses to the length of the other side *C B* 632, and setting one foot in *C*, turn the other about till it touch the line *D B*, which will be in two places, in the point *B* or point nearest to *D*, if the angle opposite to the side *C B* be Obtuse, but in the point *E*, or point farthest from *D* if Acute; according therefore to the Species of that Angle, you must draw either the line *C B* or *C E*, and then you may measure the other angles and the third side, as hath been shewed.

By the Tables, the Proportion is,

2. *C B* . *Sine D* :: *C D* . *Sine B.*

3. *Sine D* . *C B* :: *Sine C* . *E D.*

Problem VII.

Two Sides with the Angle comprehended being given, to find the other Angles, and the third Side.

In the Oblique angled plain Triangle *B C D*, let there be given,

The Sides $\left\{\begin{matrix} D C\ 865 \\ B C\ 632 \end{matrix}\right\}$ *Angle C.* 11. 07.

Draw a line at pleasure, as *D C* 865, and by your Scale set off from *C* to *D*, 865, then protract the Angle at *C* 11. 07, and draw the line *B C*, and by your Scale set off from *C* to *B* 632, and draw the line *B D*, and so have you constituted the Triangle *B D C*, in which you measure the Angles and the third side, as hath been shewed; but to resolve this Problem by the Tables, it is somewhat more troublesome.

1. To find the Angles, the proportion is,

$\frac{1}{2}$ *Z versu.* $\frac{1}{2}$ *X versu* :: *t* $\frac{1}{2}$ *Z* ∠∠ : *t* $\frac{1}{2}$ *X* ∠∠.

$\frac{1}{2}$ *Z* ∠∠ + $\frac{1}{2}$ *X* ∠∠ = *D B C.*

$\frac{1}{2}$ *Z* ∠∠ − $\frac{1}{2}$ *X* ∠∠ = *B D C.*

2. To find the third Side.

Sine D . B C :: *Sine C . B D.*

Pro-

Problem VIII.

The three sides given to find an Angle.

Let the given sides be *D C* 865. *B C* 632. and *D B* 273.

Draw a line at pleasure, as *D C*, and by your Scale set off from *C* to *D* 865, then open your Compasses to the extent of either of the other sides, and setting one foot of your Compasses in *C*, with the other draw an Occult arch, then open your Compasses to the extent of your third side, and setting one foot in *D*, with the other foot describe another Arch cutting the former in the point *B*, then will the Lines *B C* and *D B*, constitute the Triangle, whose Angles may be measured, as hath been already shewed.

To resolve this Problem by numbers, the Proportions are for the Segments of the Base.

As the base is to the sum of the other sides, so is the difference of those sides to the difference of the Segments of the Base; which being subtracted from the Base, half the remainer will shew where the perpendicular must fall, suppose at *F*, and constitute the two Right angled Trianges *B D F*, and *F D C*, in which we have given the Hypothenuses *B D* and *D C*, and the Legs *B F* and *C F*, and therefore we may find the

Angles

Angles of those Triangles, as hath been shewed in the fourth Problem.

Problem IX.

To find the Superficial content of Right lined Figures.

Having shewed the Mensuration of Triangular planes in respect of their sides and Angles, we will now shew how the Area or Superficial content of them, and any other plane Figures may be found: And because all many-sided Figures may be best Measured by reducing them first into Right angled Triangles, Quadrangles, or Trapezias, we will first shew how the Area or Superficial content of those Figures may be readily found; and first of a Right or Oblique angled plane Triangle.

1. To Measure the Right angled plane Triangle *B D F*, in Fig. 7. Multiply *B F* by *F D*, half the Product shall be the content.

2. To Measure the Oblique angled plane Triangle *B D C*, let fall the Perpendicular *D F*, then Multiply *B C* by *D F*, half the Product shall be the content.

3. To find the Area or Superficial content of any Oblique angular Trapezium, convert it into two Oblique angled Triangles, by a Diagonal, as the line *B D* in the *Trapezium A B C D*, then turn the Oblique angled

angled Triangles into Right, by letting fall the Perpendiculars *A E* and *C F*, then Multiply *B D* by the sum of *A E* and *C F*, half the Product shall be the content. In like manner may any other Irregular Multangle be also measured by turning it into Triangles and Trapeziums, and computing them severally, and adding all their contents together.

Vide A.

Problem I.

The Diameter of a Circle being given, to find the Circumference.

Vide B.

The Circumference of a Circle whose diameter is 1, is 3.14159 and therefore,

As 1 is to 3,14159, so is any other Diameter, to the Circumference answering that Diameter.

Problem II.

The Diameter of a Circle being given, to find the Superficial content.

Archimedes hath Demonstrated, that the Area of a Circle is equal to the content of a Right angled plane Triangle, whose Legs

comprehending the Right angle, are one of them equal to the Semidiameter, and the other to the Circumference of a Circle. And therefore the Area or Superficial content of a Circle may be found, by Multiplying half the Circumference by half the Diameter, or the whole Diameter by the fourth part of the Circumference, they taking the Diameter of a Circle to be one, and the Circumference 3.14159, the Superficial content of such a Circle will be found to be 0 7853975.

And therefore, As 1 is to 78539, so is the Square of any other Diameter to the Superficial content required.

Problem III.

The Diameter of a Circle being given, to find the side of a square which may be inscribed within the same Circle.

The Chord or Subtense of the fourth of a Circle, whose Diameter is 1, is 7071067 therefore, as one, to 7071067, so is the Diameter of any other Circle, to the Side required.

Problem

Problem IV.

The Circumference of a Circle being given, to find the Diameter.

By the Diameter to find the Circumference, the proportion by the tenth Problem is; As 1 to 3.14159, so the Diameter to the Circumference, and therefore putting the Circumference of a Circle to be 1.

As 3.14159 . 1 :: 1 . 318308.

And therefore as 1 to 318308, so is any other Circumference, to the Diameter fought.

Problem V.

The Circumference of a Circle being given, to find the Superficial content.

As the Square of the Circumference of a Circle given, is to the Superficial content of that Circle, so is the Square of the Circumference of any other Circle, to the Superficial content of that other Circle.

And in a Circle whose Diameter is 1, the Circumference is 3.14159, and the Area 7853975, and supposing an Unite to be the Circumference of a Circle, it is, as the square of 3.14159 . 7853975 :: 1 . 0079578, and therefore, As 1 . 0.079578, so is the

ſquare of any other Circumference, to the Area deſired.

Problem VI.

The Circumference of a Circle being given, to find the ſide of a ſquare which may be inſcribed within the ſame Circle.

As the Circumference of a Circle whoſe Diameter is 1, *viz.* 3.14159, is to 707107, the ſide of the inſcribed ſquare of that Circle, ſo is the Circumference of any other Circle, to the ſide inquired; and putting the Circumference to be Unity, it is, as 3.14159 . 707107 :: 1 , 225078, therefore,

As 1 *to* 225078, *ſo* is the Circumference given, to the ſide inquired.

Problem VII.

The ſuperficial content of a Cirtle being given to find the Diameter.

This is the Converſe of the 11. *Problem*, the Diameter given, to find the Content, for which the Proportion is, *as* 1 *to* 7853975, *ſo* is the ſquare of the diameter, *to* the content: and therefore we muſt ſay; as 7853975 *is to* 1 *ſo* 1 *to* 1.27324; and hence, *as* 1 *to* 1.27324, *ſo* is the Area, *to* the Square of the Diameter.

Problem

Problem VIII.

The Superficial content of a Circle being given, to find the Circumference.

This is the Converſe of the 14. *Problem*, the Circumference given, to find the Content.

As 1 *to* 079578, *ſo* Circumference ſquare, *to* the Content: And therefore,

As 079578 . 1 :: 1 . 12.5664, and by conſequence,

As 1 *to* 12.5664, *ſo* the Area, *to* the Square of the Circumference.

Vide C.

Problem IX.

The Axis or Diameter of a Sphere being given, to find the Superficial Content.

As the ſquare of the Diameter of a Circle, which ſuppoſe 1, *is to* 3.14159 the Area, *ſo* is the ſquare of the Axis given, *to* the Area that is required.

CHAP. IV.

Of Bodies or Solids.

AFter the description of lines and planes, the Doctrine of Bodies is to be considered.

2. A *Solid* or *Body*, is that which hath Length, Breadth and Thickness, whose bounds or limits are Superficies.

3. A *Solid* is either Plane or Gibbous.

4. A *Plane Solid*, is that which is comprehended of Plane Superfices, and is either a Pyramide or Pyramidate.

5. A *Pyramide*, is a solid Figure, which is contained by Planes, set upon one Plane or Base, and meeting in one point.

6. A *Pyramidate*, is a solid Figure, composed of Pyramides, and is either a *Prisme* or a mixt *Polyhedron*.

7. A *Prisme*, is a Pyramidate or solid Figure, by Planes, of which these two which are opposite, are equal, like, and parallel and all the other Planes are parallelograms.

8. A *Prisme*, is either a *Pentahedron*, a *Hexahedron*, or a *Polyhedron*.

9. A *Pentahedron Prisme*, is that, which comprehended of five sides, and the Base Triangle.

10. A

10. An *Hexahedron Prisme*, is that which is comprehended of six sides, and the Base a Quadrangle.

11. An *Hexahedron Prisme*, is either a *Parallelipipedon*, or a *Trapezium*.

12. A *Parallelipipedon*, is that whose sides or opposite planes are parallelograms.

13. A *Prisme*, called otherwise a *Trapezium*, is that solid, whose opposite planes or sides are neither parallel nor equal.

14. A *Parallelipipedon*, is either Right angled or Oblique.

15. A *Right angled Parallelipipedon*, is that which is comprehended of right angled sides, and it is either a *Cube* or an *Oblong*.

16. A *Cube*, is a Right angled parallelipipedon of equal sides.

17. An *Oblong*, is a right angled parallelipipedon of unequal sides.

18. An *Oblique angled Parallelipipedon*, is that which is comprehended of oblique sides.

19. A *Polyhedron*, is that which is comprehended of more than five sides, and the Base a Multangle.

20. A mixt *Polyhedron*, is that whose Vertex is in the Centre, and the several sides exposed to view, and of this sort, there are only three; the *Octahedron*, the *Icosohedron*, and the *Dodecahedron*.

21. An *Octahedron*, is a solid Figure, which is contained by eight Equal and Equilateral Triangles.

22. An

22. An *Icosahedron*, is a solid Figure, which is contained by twenty Equal and Equilateral Triangles.

23. A *Dodecahedron*, is a solid Figure, which is contained by twelve Pentagons, Equilateral and Equiangled.

24. A *Gibbous solid*, is that which is comprehended of Gibbous Superficies, and it is either a Sphere or Various.

25. A *Sphere*, is a Gibbous body, absolutely Round and Globular.

26. A *Various Gibbous Body*, is that which is comprehended by various superficies and a circular base; and is either a *Cone*, or a *Cylinder*.

27. A *Cone*, is a Pyramidical Body, whose Base is a Circle.

28. A *Cylinder*, is a solid Body of equal thickness, having a Circle for its Base. The solid content of these several Bodies may be measured by the Problems following.

Problem I.

The Base and Altitude of a Pyramide or Cone given, to find the Solid Content.

Multiply the Altitude by a third part of the Base, or the whole Base by a third part of the Altitude, the Product shall be the solid Content required.

Problem

Problem II.

The Base of a Prisme or Cylinder being given, to find the solid content.

Multiply the Base of the Prisme or Cylinder given, by the Altitude, the Product shall be the solid content.

Problem III.

In a Piece or Frustum of a Pyramide, Cone or other irregular Solid, both the bases being given, to find the content.

If the Aggregate of both the Bases of the Frustum, and of the mean Proportional between them, be drawn into the Altitude of the Frustum, the third part of the Product shall be equal to the solid content required.

Problem IV.

The Axis of a Sphere being given, to find the solid content.

A Sphere (as *Archimedes* hath shewed) is equal to two thirds of a Cylinder circumscribing it; now then, such a Cylinder being made; by the Area of a Circle multiplyed by the Diameter; and therefore the

Area of a Circle being multiplied by two thirds of the Diameter, the Product ſhall be the ſolid content of a Sphere.

The Area of a Circle whoſe Diameter is 1, is 7853975, which being multiplied by 666666, the two thirds of the Diameter, the Product 523598 is the ſolid content of ſuch a Sphere; therefore,

As 1 *to* 523598, *ſo* is the Cube of any Axis given, to the ſolid content required.

FINIS.

THE *ENGLISH* ACADEMY:

The FOURTH PART.

Of MUSICK.

CHAP. I.

Of SINGING.

MUSICK is the Art of modulating Notes in Voice or Inſtrument.

2. It doth conſiſt in *Singing* or *Setting*.

3. In *Singing* there are five things to be conſidered: 1. The Number of the Notes. 2. Their Names. 3. Their Tunes. 4. Their Times. And 5. Their Adjuncts.

4. The number of Muſical Notes are three times ſeven, or twenty one, that is from the loweſt Note of a Man's Baſe, to the higheſt of a Boy's Treble, we uſually reckon twenty one Notes; though there are ſome

Bases that reach below, and some Trebles that arise above this ordinary compass.

The number of Musical Notes is therefore divided by Septenaries, because there are in Nature, but seven distinct sounds expresst in Musick, by *seven* distinct Notes, in the several Cliffs or Cleaves of the Scale; for the *eighth* & *fifteenth* have the same sound or tune, and therefore the *name* and *cliff* of the first; the *9th* and *16th* of the second; the *10th* and *17th* of the third; the *11th* and *18th* of the fourth; the *12th* and *19th* of the fifth; the *13th* and *20th*, of the sixth; the *14th* and *21th*, of the seventh.

6. These thrice seven Notes are descerned by their places. A *place* is either a Rule or space, and therefore in eleven rules with their spaces, is comprehended the whole scale.

7. At the beginning of each *rule* and *space* is placed one of the first seven Letters in the Alphabet, and these Letters are thrice repeated one above another, the letter *G* being put upon the first or lowest place of each sepentary being the first letter in the word *Greece*, and in the first sepentary, retained the Name and Form of the Greek *Gamma*, in remembrance, that the Art of *Musick*, as other learned Arts came to us from that seat of the Muses.

8. By these seven letters of the Alphabet, otherwise called seven *cliffs* or *cleaves*, the scale

scale is divided into three several parts of *Musick*; the first and lowest is called the *base*; the 2d. or middle part, the *Mean*; the third or highest part, the *Treble*. As for the Notes, which do exceed this compass, either in the *base* or *treble*, they are signed with double letters in the same manner, that the ordinary Notes are with single.

9. The second thing to be considered in *Singing*, is the Name by which each of these Notes is called.

10. And for these seven notes, signed by the first seven letters in the Alphabet, there are but *six* several *names invented* to *help* the learner in the tuning of them; *ut*, *re*, *Mi*, *fa*, *sol*, *la*, and for the *seventh* note, because it is but half a tone above *la*, as the fourth is above *Mi*, (whereas the rest are all whole tone) it is fitly called by the same name with the *fourth*, and so the next will be an *eight*, or *Diapason* to the first, and consequently placed in the same letter or cliff, and called by the same name.

And thus they were wont to be placed in the scale, in which the first name *ut* being placed upon the same line with the Greek *Gamma*, hath caused the whole scale to be called the *Gamut*; but modern Musicians in these latter times, have rejected the names of *ut* and *re*, as finding the other four to be sufficient for the expressing of the several sounds, and less burthensome to the Memories of Practitioners.

11. This scale or *Gamut* then, is divided into

four Columns. In the first you have the Alphabetical *letters* or *cliffs*, the other three shew the *names* of the notes, *ascending* and *descending*, according to their *several names* & keys.

In the second column is set the names of the notes as they be called, where is *B dura*lis, or *B sharp*, as having no flat in *B mi*, and then your notes are called as they are set there on the rules and spaces ascending.

In the third Column is *B proper*, or *B naturalis*, which hath a *B flat* in *B mi* only, which is put at the beginning of the line with the Cliff, and there you have also the names as they are called on Rule and Space.

In the fourth Column is *B fa*, or *B molaris*, having two *B flats*, the one in *B mi*, the other in *E la mi*, placed as the other; by observing of which you have a certain rule for the Names of the Notes in any part.

12. In these *three* colums *observe* this for a *general rule*, that what *name* any *note* hath, the same *name properly* hath his *eight above* or *below*.

13. Although the whole ordinary scale of *Musick* doth contain *three* septenaries of lines and spaces; yet when any of the parts which it is divided into, shall come to be Prick'd out by it self in *Songs* or *Lessons*, five Lines is only usual, for one of those Parts as being sufficient to contain the compass of notes thereunto belonging: And if there be any Notes that extend higher or lower, it is usual to add a Line in that place with a Pen.

THE GAM-VT OR SCALE OF MU[SICK]

14. Though the seven Letters set at the beginning of each Rule and Space, are seven *Cleaves*, yet four of them are only usual; The first is called the *F fa ut Cleave* or *Cliff*, thus marked 𝄢 this is proper to the *Base* or lowest Part, and is set upon the fourth line, at the beginning of Songs or Lessons. The second is the *C sol fa ut*, which is proper to the middle or inner parts, and is thus marked 𝄡. The third is the *G sol re ut Cleave* or *Cliff*, which is only proper to the *Treble* or highest, and is signed thus, 𝄞 on the second line of the Songs or Lessons; and these are called the three signed Cliffs.

The fourth is the *B Cliff*, which is proper to all Parts, as being of two natures and properties; that is to say, *Flat* and *Sharp*, and doth only serve for the *Flatting and Sharping* of Notes; it is called by two Names, and signed by two Marks, the one is *B fa*, or *B flat*, and is known on Rule or Space by this mark, (♭) The other is called *B mi* or *B sharp*, and is known by this mark ♯.

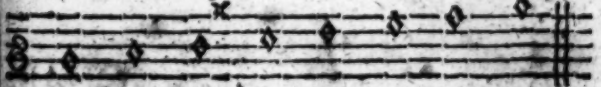
15. Concerning this fourth Cliff, you are to observe: 1. That the *B fa*, or *B flat* doth alter both the Name and Property of the Notes before which it is placed; changing *mi* into *fa*, and making that Note to which he is joyned, a Semi-tone, or half a note lower. 2. That the *B mi* or *B sharp* alters the property of the Notes before which he is placed but not the Name; for he is usually placed

ced either before *fa* or *sol*, and they retain their name still, but their sound is raised half a Tone or Sound higher. Lastly, note, that these two *B* Cliffs are placed not only at the beginning of the Lines with the other Cliff, but is usually put to several Notes in the middle of any Song or Lesson, for the *flatting* and *sharping* of Notes, as the Harmony of the Musick doth require.

16. Of these four Notes now in use, *Mi* is the principle or master Note, for that being found, the rest are known by this direction; after *Mi*, sing *fa sol la*, twice upward and *la sol fa*, twice downward, and so you come to *Mi* again in the same Cliff both wayes.

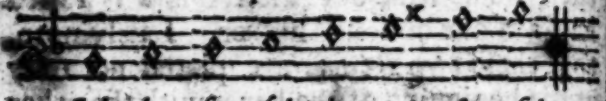
17. This Note *Mi*, hath his being in four several places, but he is but in one of them at a time. Its proper place is in *B mi*, as in the second Column of the *Gamut*; but if a *B fa*, or *B flat*, be in its place, then he is in *E la mi*, as in the third Column of the *Gamut*, which is its second place. But if a *B flat* be placed there also, then its in *A la mi re*, which is its third place. If a *B flat* come there also, then it is remov'd into its fourth place, which is *D la sol re*, according to these Examples.

I. *Example.* *Mi* in *B mi.*



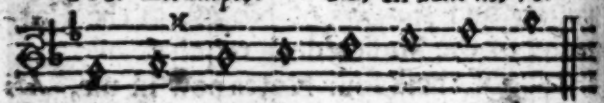
Sol la mi fa sol la fa sol.

II. *Example.* *Mi* in *E la.*



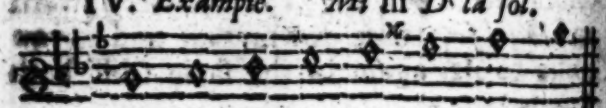
Sol la fa sol la mi fa sol.

III. *Example.* *Mi* in *A la mi re.*



La mi fa sol la fa sol la.

IV. *Example.* *Mi* in *D la sol.*



La fa so la mi fa sol la.

CHAP.

CHAP. II.

Of the Tunes of Notes.

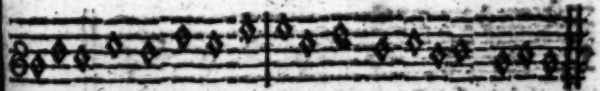
THe next thing to be conſidered in Singing, is the Tunes of Notes, which cannot be declared by Precept, but muſt be learned either by the lively Voice of the Teacher, or by ſome Inſtrument rightly Tuned. Only obſerve that from *mi* to *fa*, and ſo from *la* to *fa*, is but half a Tone; but between any other two Notes is a whole Tone, as from *fa* to *ſol*, or *ſol* to *la*. And in the firſt guiding of the Voice, it will much help, if at the firſt Tuning, you ſound by degrees all theſe Notes, as *ſol la mi*, and at the ſecond Tuning, leave out *la* the middle Note: this will not only help you to Tune a Third, as from *ſol* to *mi*, but it will alſo help you in the raiſing of Fourths and Fifths, *&c.*

Of which there are ſome Examples in the plain Songs following.

Firſt.

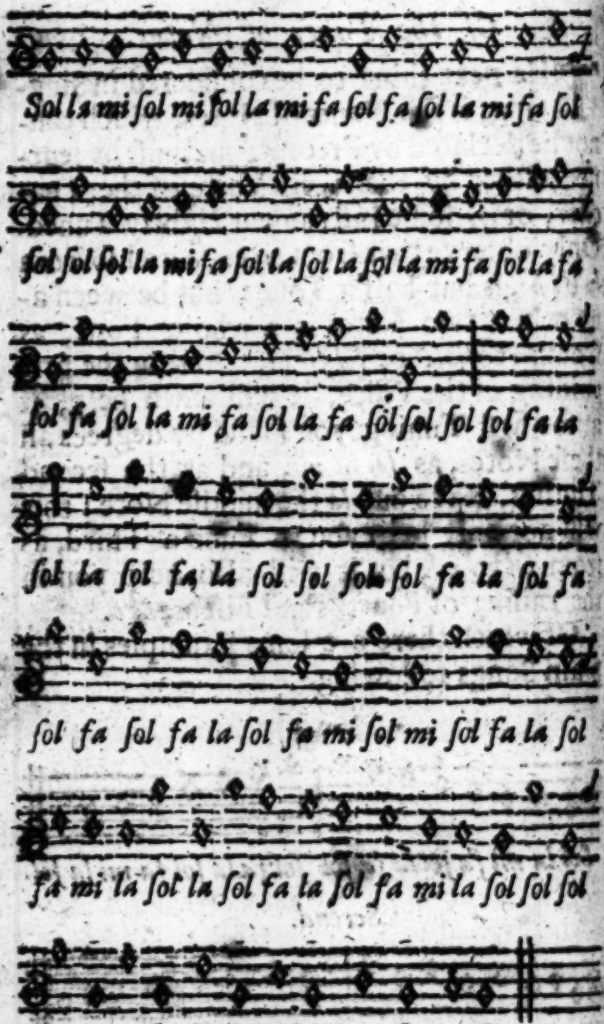
Sol la mi fa ſol la fa ſol ſol fa la ſol fa mi la ſol.

Second.



Sol mi la fa mi ſol fa la la fa ſol mi fa la mi ſol la ſo

Third.


Sol la mi sol mi sol la mi fa sol fa sol la mi fa sol
sol sol sol la mi fa sol la sol la sol la mi fa sol la fa
sol fa sol la mi fa sol la fa sol sol sol sol fa la
sol la sol fa la sol sol sol sol fa la sol fa
sol fa sol fa la sol fa mi sol mi sol fa la sol
fa mi la sol la sol fa la sol fa mi la sol sol sol
fa sol la sol sol sol fa sol mi sol la sol.

CHAP.

CHAP. III.

Of the Time of Notes.

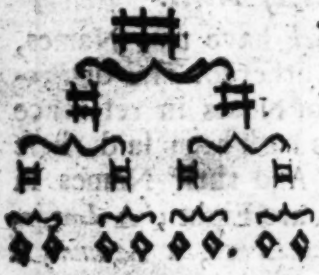
THe Notes in *Muſick* have two Names, one for *Tune*, the other for *Time* or *Proportion*. The Names of Notes in reference to their *Tunes*, are, as hath been ſaid, theſe four, *Sol La Mi Fa*; And their Names in Proportion of *Time*, are Eight; A *Large*, a *Long*, a *Breve*, a *Semi-breve*, a *Minum*, a *Crotchet*, a *Quaver*, a *Semi quaver*.

The four firſt are of Augmentation, or Increaſe; the four latter are of Diminution or Decreaſe, and are thus proportioned. The *Large* being the firſt of Augmentation, and longeſt in Sound; the *Semi-breve* is the laſt of Augmentation, and the ſhorteſt in Sound, and in *Time* is called the Maſter-Note, being of one Meaſure by himſelf, all the other Notes are reckoned by his value, both in Augmentation and Diminution.

In Augmentation, the *Large* is Eight *Semi-breves*, the *Long* four, the *Breve* two, the *Semi-breve* is one *Time* or *Note*.

In Diminution, the latter four do decreaſe in this proportion; two *Minums* make a *Semi-breve*, two *Crotchets* make a *Minum*, two *Quavers* make a *Crotchet*, and two *Semi-quavers* make a *Quaver*. As in the Table following may be ſeen.

Notes of Augmentation.



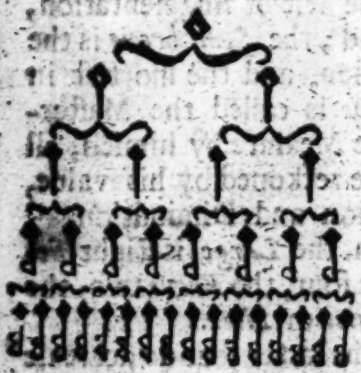
—*A Large.*

—*A Long.*

—*A Breve.*

—*A Semi-breve.*

Notes of Diminution.



—*A Semibreve.*

—*A Minim.*

—*A Crotchet.*

—*A Quaver.*

—*A Semiquaver.*

CHAP.

CHAP. IV.

Of the Adjuncts belonging to Musical Notes.

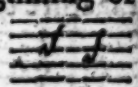
THere belong to Notes, thus described by their Number, Names, Tunes, and Time, these seven things. A *Tye*, a *Repeat*, a *Pause*, a *Direct*, a *Close*, with single and double *Bars*, and several *Moods*.

2. A *Tye* is a Semi-circle, whose two ends point to the two Notes conjoyned, as when two *Minums*, or one *Minum* and a *Crotchet* are tyed together; as also, when two or more Notes are to be Sung to one Syllable, or two Notes or more to be plaid with one drawing of the Bow on the *Viol* or *Violin*.

3. The middle and principal Note is the *Semibreve*: And when any Note & his half note in the same place are conjoyned for one Syllable, the mark of the half Note, and of the Ligature too, is a point set by the Note, and it is as much, as if with the *Note* his half *Note* were expresst, and conjoyned by Ligature, and prolongeth the sound of that Note it follows, to half as much more; thus a *Semi-breve*, which is of it self but two *Minums*, having a prick after it, is made three *Minums*, in one continued sound, and so in other Notes.

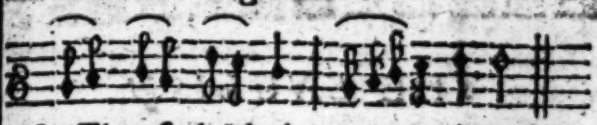
4. A *Repeat* is either of the same Notes and Ditty together, or of Ditty with other Notes, and is marked thus, 𝄋 and is used to signifie, that such a part of a Song or Lesson must be Play'd or Sung over again from that Note over which it is placed.

5. A *Pause* is a mark of rest or silence in a Song for the time of some Note, whereof it hath its name. A line descending from a superiour Rule, and not touching the Rule below, is a *Semibreve* Rest: the like line rising from an inferiour Rule, and not touching the Rule above, is a *Minum* Rest: the same with a crook to the Right hand, is a *Crotchet* Rest, and to the left hand, a *Quaver* Rest: Also a line reaching from Rule to Rule, is a *Breve* Rest, or a *Pause* of two *Semibreves*; a line from a Rule to a third Rule, is a *Long* pause, or of four *Semibreves*, and two of them together make a *Large* pause, or a Rest of Eight *Semibreves*.

6. A *Direct* in the end of a line, sheweth where the Note stands in the beginning of the next line, and is marked thus, 

7. A *Close* is either Perfect or Imperfect; A Perfect Close is the end of Song, noted thus, 𝄐 or thus, 𝄑 or with two Bars thwart all the Rules, or both ways. An Imperfect Close, is the end of a Strain, or any place in a Song, where all the Parts do meet

meet and Close before the end, and it is marked with a single Bar.



8. The usual *Moods* are two, the *Imperfect of the more*, when all goes by two, except the *Minims*, which goes by three, as two *Longs* to a *Large*, two *Breves* to a *Long*, two *Semibreves* to a *Breve*, three *Minums* to the *Semibreve*, with a prick of perfection; this Mood is thus signed, C 3 and is usually called the *Triple Time*.

The other usual *Mood* is the *Imperfect of the less*; when all goes by two, as two *Longs* to a *Large*, two *Breves* to a *Long*, two *Semibreves* to a *Breve*, &c. this is called the *Common Time*, because most used, and is marked thus, .

Thus much concerning singing; I leave setting to the larger Treatises of this subject.

FINIS.

THE *ENGLISH* ACADEMY:

The FIFTH PART.

OF ASTRONOMIE.

CHAP. I.

Of the General Subject of Astronomie.

Astronomy, is an Art, by which we are Taught the Measure and Motion of the heavenly Orbs and Stars that are in them.

2. The Heavenly Orbs are either ἄναστοι, without Stars, as the *Primum Mobile*, or ἔναστοι, such as have Stars in them, as the eight inferiour Orbs.

3. The Stars are either fixed or moveable: The fixed Stars are those which always keep the same distance from one another: but the moveable Stars, otherwise called Planets,

Planets, are such as do not always keep the same distance.

4. All the Stars, as well fixed as moveable have a double motion; the one occasioned by the *Primum Mobile*, from East to West, the other natural or proper to themselves, by which they move from West, to East.

5. According to this double motion of the Stars, this Art of *Astronomy* is divided into two Parts; the first sheweth the motion of the *Primum Mobile*, and how the several Heavenly Orbs are by that carried round the World, from East to West, which is called the *Diurnal motion* of the Stars.

The second part of *Astronomy*, sheweth the *Periodical motion* of the Stars, in which the inferiour Orbs, according to their own proper and natural motion, do move from West to East.

6. For the better understanding of these several motions, the *Primum Mobile*, or tenth Orb, is usually represented by a Sphere or Globe, with such lines drawn about it as the Stars in their motions are supposed to make, or may help to discover unto us, the quantity of their motions, and shew the time of their Risings and Settings, and such like.

7. This Sphere or Globe, is a round body, containing one Superficies, in the middle whereof there is a Point, from whence all Right Lines drawn to the Superficies are equal.

8. *In* the Sphere or Globe, there are ten imaginary Lines or Circles, of which six are great, and four are small.

9. The great Circles are these which divide the Sphere or Globe into two equal *Hemispheres*, and such are the *Horizon*, *Æquinoctial*, *Zodiack*, and the two *Colures*; the two first of which are called *external* and *mutable*, the other *internal* and *immutable*.

10. The Lesser Circles, are those which divide the Sphere or Globe into two unequal *Hemispheres*, whereof one is more, and the other less, than the half of the Sphere or Globe; such are the two *Tropicks* of *Cancer* and *Capricorn*, and the *Artick* and *Antartick* Circles, all which are represented in *Fig.* 9.

11. The *Horizon*, which is also called the *Finitor*, is a Circle, which divideth the visible part of the Heavens from the not visible; that is, the lower *Hemisphere* from the upper, as the line *A B*; one of whose Poles is in the Point directly over our heads, and is called the *Zenith*, the other Diametrically opposite, called the *Nadir*, and noted with the Letters *Z. N.*

12. The *Horizon*, is either *Sensible* or *Rational*.

13. That is called the *Sensible Horizon*, which bounds our sight, and seemeth to divide the Heavens into two equal Hemispheres.

14. The

14. And that is called the *Rational* or *Intelligable Horizon*, which doth indeed biſect the Heavens; and this is Right, when it paſſeth through the Poles of the World; or Oblique, when one of the Poles is ſomewhat elevated, and the other depreſſed; or Parallel, when one Pole is in the Vertical Point or *Zenith*, for then the *Horizon* is Parallel to the *Æquator*; it otherwiſe makes therewith either Right or Oblique Angles.

15. Hence there is a threefold poſition of Sphere. 1. A *Right*, where the *Horizon* is Right; that is, where the *Æquator* paſſeth through the *Zenith* and *Nadir*, 2. *Oblique*, when the *Horizon* is *Oblique*; that is, when one Pole is ſomewhat elevated and the other depreſſed. 3. *Parallel*, when one of the Poles of the world is in the *Zenith*.

16. *In a Right Sphere*, all the Stars do Riſe and Set, but in an *Oblique Sphere*, ſome are hid from our ſight, and ſome are always above the *Horizon*.

17. The *Meridian* is a great Circle peculiar and proper to every place, and drawn through the *Vertical point* and the *Poles of the World*, to which when the Sun comes in his Diurnal motion, in the Day-time he maketh the Mid-day, and in the Night time, he maketh Midnight. There may be as many *Meridians* as there are *Vertical points*, but upon the Globe they are uſually drawn thro' every tenth or fifteenth Degree of the *Æquator*.

CHAP. II.

Of the Internal and Immutable great Circles.

HItherto of the two External and Mutable Circles, the *Horizon* and *Meridian*, I come now to the Internal and Immutable.

2. The first Internal and Immutable Circle is called the *Æquator*, or *Equinoctial Circle*, which divideth the whole Sphere or Globe into two equal parts between the Poles, to which when the Sun cometh, which is twice in the Year, the days and nights are equal in all places but in a Parallel Sphere: this Circle is noted with the letters *E F*.

3. This Circle is also the measure of Time; for as oft as 15 Degrees of this Circle do ascend above the *Horizon*, so many hours are compleated in its going round.

4. The second Immutable Circle is called the *Zodiak*, which is a great Oblique broad Circle, under which the Planets do always move; the Poles of this Circle are distant from the Poles of the world 23 Degrees, 31 Minutes, and 30 Seconds, or 23.53 Centesms.

5. This Circle doth differ from other Circles in the Heavens, in that other Circles to speak properly, have Longitude or Length,

Length, but no Breadth, whereas this Circle is allowed to have both.

6. In respect of Longitude, this Circle is divided as other Circles commonly are into 360 Degrees, but more peculiarly into 12 parts, constituting, as it were, the 12 Parts or Months of the Year, or 12 Constellations of Stars, called Signs, each Sign being subdivided into 30 Degrees or Parts. The Names and Characters of these 12 Constellations, or Signs, are as followeth. *Aries* ♈, *Taurus* ♉, *Gemini* ♊, *Cancer* ♋, *Leo* ♌, *Virgo* ♍, *Libra* ♎, *Scorpio* ♏, *Sagittarius* ♐, *Capricornus* ♑, *Aquarius* ♒, *Pisces* ♓.

7. The *Zodiack*, in respect of Latitude, is divided into 16 Degrees, that is, into 8 Degrees North-ward, and 8 Degrees South-ward, because all the Planets, except the Sun, do in their Motions vary from the middle Line, sometimes one way, and sometimes another; to the quantity of 8 Degrees; and the middle Line in which the Sun moves, is the *Ecliptick* Line, because when the Sun and Moon are in Conjunction, the Sun is Eclipsed, but when they are in Opposition, the Moon is Eclipsed.

8. Of these 12 Signs, 4 are called Cardinals, *viz.* *Aries* and *Libra*, in which do happen the Vernal and the Autumnal *Equinoctials*; *Cancer* and *Capricorn*, in which do happen the Summer and the Winter Solstices.

9. Again these Signs are distinguished into Northern and Southern; the Northern signs are those which decline from the Æquator towards the North Pole, as ♈, ♉, ♊, ♋, ♌, ♍; And the Southers signs are those which decline from the Æquator towards the South Pole, as ♎, ♏, ♐, ♑, ♒, ♓.

10. All other Constellations of fixed stars are referred to some one or other of the 12 signs, whether they be the 21 Northern constellations, called *Ursa Minor, Ursa Major, Draco, Cepheus, Arctophylax, Corona Borealis, Engonasus, Lyra, Avis, Cassiopeia, Persius, Heniochus, Serpentarius, Serpens, Sagitta, Aquila, Delphinus, Equisectio, Pegasus, Andromeda, Triangulus.* Or whether they be the 15 Southern constellations, called *Cetus, Orion, Eridanus, Lupus, Canis Major, Procyon, Argo, Hydra, Crater, Corvus, Centaurus, Fera, Ara, Corona Austr. Pisces Austra.* 15.

11. The two other great Circles called the *Colures*, are the two Circles which pass through the Poles of the World, and the four Cardinal points in the *Zodiack*.

12. That circle which passeth thro' the Poles of the world, and the two Solstitial points in the Zodiack, which are the beginnings of ♋ and ♑, and is called the Solstitial Colure.

13. That Circle, which passeth through the poles of the world and the two Æquinoctial points, or first entrance into ♈ and ♎, is called the *Æquinoctial Colure*, and in *Fig.* 9. represented by the line *D. C.* 14. The

14. The Lesser Circles of the Sphere are the two Tropicks of ♋ and ♑ with the Artick and Antartick Circles.

15. The *Tropick* of ♋ is a Circle joyned to the Zodiack in the beginning of ♋, and is described by the Suns Diurnal Motion, when he is in the Summers Solstitial point, and is distant from the Æquinoctial towards the North Pole 23 *deg.* 31′ 30″ or in Decimal Numbers, 23 *deg.* 5. 25. to which when the Sun cometh, he causeth the longest day and shortest night to all Northern; the shortest day and longest night to all Southern Inhabitants; and is noted with *G* ♋.

16. The *Tropick* of ♑, is a Circle joyned to the Zodiack in the beginning of ♑, and described by the Suns Diurnal Motion, being in the winters Solstitial point, and is distant from the Æquinoctial towards the South P[illegible]3 *deg.* 31′ 30″, or in Decimal Numbers, 23 *deg.* 5.25 *parts*, to which, when the Sun cometh, he maketh the longest day and shortest night, to all Southern; the shortest day and longest night to all Northern Inhabitants, and is noted with *H* ♑.

These two Circles are called of the *Greeks* Τροπικοὶ, *à convertendo*, because when the Sun toucheth any of the Circles, he is at his greatest distance from the Æquator, and returneth thither again.

17. The *Artick Circle*, is distant from the North Pole of the world, as much as the

the Tropick of ♋ is distant from the Æquinoctial, and is noted with *K L*.

The *Antartick Circle* is distant from the *South Pole* as much as the *Tropick* of ♑ is distant from the Æquator, & is noted with *O M*.

18. By the Intersection of any three of the greatest Circles of a Sphere is made a *Spherical Triangle*.

19. A *Spherical Triangle*, is either Right Angled or Oblique.

20. A *Right Angled Spherical Triangle*, hath one Right Angle at the least.

21. An *Oblique Angled Spherical Triangle*, is either Acute or Obtuse.

22. An *Acute Angled Spherical Triangle*, hath all its Angles Acute.

23. An *Obtuse Angled Spherical Triangle*, hath all his *Angles*, either *Obtuse* or *mixt*, that is *one Angle* at the least *Obtuse*, and the other *Acute*.

24. In *Spherical Triangles*, there are 28 Varieties or Cases, 16 in *Rectangular*, and 12 in *Oblique Angular*, whereof all the *Rectangular* and 10 of the *Oblique Angular*, may be resolved by one Catholick, and Universal Proposition; for the understanding whereof, some things must be premised.

1. That in a *Right Angled Spherical Triangle*, the *Hypotenuse* and both the *Acute Angles* are supposed to be noted with their *Complements*.

2. That the *Right Angle* is not reckoned amongst the Circular parts, and therefore one of the other five will be always a middle part, and the other four extreams *Conjunct* or *Disjunct*.

The

The Proposition is this:

A Rectangle made of the Sine of the middle part & Radius, is equal to the Rectangle made of the Tangents of the Extreams Conjunct, or of the Cosins of the Extreams Disjunct: Therefore,

When two things are given, and a third required, you must first find out the middle part, and where the other Terms be Extreams Conjunct or Disjunct; if the things given and inquired lie together, the middle is the middle part, but if they be disjoyned, that which standeth by it self is the middle part.

Note also, that when a Complement in the Proposition doth chance to concur with a Complement in the Circular Parts, you must take the Sine it self, or the Tangent it self, because cs *of the* cs = S. *and* ct *of the* ct = t.

25. These things being understood, the Analogies to be used in every of the 16 Cases of a Right angled Triangle, will from this Proposition be as followeth.

	Data	Q.	Analogia.
1	$\frac{BC}{A}$	AB	$Rad\ cot.\ A :: t\,BC.\ s\,AB.$
2	$\frac{A}{AB}$	BC	$cot\ A.\ Rad :: s\,AB.\ t\,BC.$
3	$\frac{AB}{BC}$	A	$t\,BC.\ s\,AB :: Rad.\ ct\ A.$

4. AB

4	$\frac{AB}{A}$	AC	$t\,AB : cs\,A :: Rad. cot\,AC.$
5	$\frac{AC}{AB}$	A	$R\,cot.\,AC :: t\,AB. cs\,A.$
6	$\frac{AC}{A}$	AB	$cot\,AC. Rad :: cs\,A. t\,AB.$
7	$\frac{A}{C}$	AC	$Rad. ct\,C :: ct\,A. cs\,AC.$
8	$\frac{AC}{A}$	C	$ct\,A. cs\,AC :: ct\,C.$
9	$\frac{AC}{A}$	BC	$Rad. s\,A :: s\,AC. s\,BC.$
10	$\frac{BC}{A}$	AC	$S\,A. s\,BC :: Rad. s\,AC.$
11	$\frac{AC}{BC}$	A	$S\,AC. s\,BC :: Rad. s\,A.$
12	$\frac{AB}{A}$	C	$Rad. s\,A :: cs\,AB. cs\,C.$
13	$\frac{AB}{C}$	A	$cs\,AB. cs\,C :: Rad. s\,A.$
14	$\frac{A}{C}$	AB	$s\,A, cs\,C :: Rad. cs\,AB.$

15.

15	AB, BC	AC	Rad cs AB :: csBC . cs AC.
16	AC, AB	BC	cs AB, cs AC :: Rad. csBC.

26. In *Oblique-angled Spherical Triangles*, there are, as hath been said, 12 Cases, 10 whereof may be resolved by the Catholick Proposition, if the Spherical Triangle propounded be first converted into two Right, which may be done by this General Rule.

From the end of a side given, being adjacent to an Angle given, let fall the Perpendicular.

A Type of the several Varieties here followeth.

1.	AC, CD, D	A	Rad . SC D :: s D . s BC. s AC . Rad :: s BC . s A.
2.	CD, A, D	AC	s A . s D :: s C D . s AC.
3.	AC, CD, D	AD	cot C D . R :: cs D . t B D. cos B D . cs C D :: R . cs BC. R : cs BC :: cs AC . cs AB. BD + AB = AD. 1 Tri. BD — AB = AD. 2 Tri.

4.	AC CD D	C	ct D. Rad :: cs C D. ct BCD. ct C D. cs BC D :: R. t BC. R. t BC :: ct AC. cs AC B. BCD + ACB = ACD. 1. Tri. BCD — ACB = ACD. 2. Tri.
5.	A D CA	C	ct A. R :: cs AC. ct ACB. s ACB. cs CAB :: R. cs BC. cs BC. R :: cs BDC. cs BCD. ACB + BCD = ACD. 1. Tri. BCD — ACB = ACD. 2. Tri.
6.	A D AC	AD	ct. AC. R :: cs D AC. t AB. ct. D AC. R AB :: R. t BC. R. t BC :: ct ADC. s BD. AB + BD = AD. 1. Tri. RD — AB = AD. 2. Tri.
7.	A A AC	D	ct. C AB. R :: cs AC. ct ACB. ACD — ACB = BCD. 1. Tri. ACD + ACB = BCD. 2. Tri. s ACB. cs CAB :: R. cs BC. R. cs BC :: s BCD. cs CDB.
8.	A C AC	DC	ct C AB. R :: cs AC. ct ACB. ACD — ACB = BCD. 1. Tri. ACD + ACB = BCD. 2. Tri. ct AC. cs ACB :: R. t BC. t BC. Rad. :: cs BCD. ct DC.

9.	AD AC A	D C	ct AC. R :: cs C AD. t AB. AD − AB = BD. 1. Tri. AD + AB = BD. 2. Tri. cs AB. cs AC :: R. cs BC. R. cs BC :: cs BD. cs DC.
10.	AC AD A	C	ct AD. R :: cs C AD. t AE. AE − AC = CF in 1. Tri. AE + AC = CF 2. Tri. ct C AD. s AE :: R. t DF. t DF. R :: s CF. ct DCF.
11.	AC AD DC	C	s AC × s CD. Rad. square. s ½ z − AC × s ½ z − CD. Q. s¹ C.

The Twelfth, is but the Converse of the last taking the Angles for Sides, and the Sides for Angles; so shall the Angle found, be the Side inquired.

CHAP. III.

Of the Ascensions and Descensions of the Parts of the Zodiack.

HItherto we have spoken of the general Principles of *Astronomy*, from whence the motion of the *Primum Mobile* is explained; come we now to these affections which properly belong to the motion thereof, and these are the Ascension and Descension of

of the Parts of the Zodiack, or Aſtronomical Riſing and Setting.

2. *Aſtronomical Riſing and Setting*, is the Elevation of the parts of the Zodiack or Ecliptick above the Horizon, and Depreſſed under it, compared to the Aſcenſion and deſcenſion of the parts of the Æquator; and this compariſon is in reference to diverſe Elevations of the Poles.

3. But this Aſtronomical Riſing and Setting, takes his Denomination from the parts of the Zodiack; which are above the Horizon or beneath it, and are meaſured with reſpect unto the Æquator; for Aſtronomers do not refer the Æquator to the Zodiack, but the Zodiack to the Æquator, for it is Zodiack, and not the Æquator which ſtands in need of meaſuring.

4. And an Arch of the Ecliptick or Zodiack, is to be underſtood two manner of ways; namely, *Continued* or *Diſcreet*; A *Continued Arch*, is when it is reckoned in the Æquator in a Continued Series, from the beginning of *Aries*, and ſo forward into the conſequent Signs.

5. A *Diſcreet Arch*, is ſo called, becauſe it is not reckoned from the firſt Degree of *Aries*, but from any other point; as from the fourteenth of *Gemini*, to the fourteenth of *Taurus*.

6. Any part of the Zodiack is then ſaid to Aſcend Right, when a greater part of the Æquator

Æquator riſeth above the Horizon than of the Zodiack. And that is ſaid to be a greater Arch of the Æquator, which is more than 90 Degrees.

7. Any part of the Zodiack is then ſaid to Deſcend Right, when a greater part of the Æquator than of the Zodiack is beneath the Horizon.

8. Any part of the Zodiack therefore is ſaid to Aſcend Obliquely, when a leſs part of the Æquator than of the Zodiack doth Aſcend; as alſo, to Deſcend Obliquely, when leſs of the Æquator than of the Zodiack is below the Horizon.

9. *Aſcenſion*, is either Right or Oblique.

10. *Right Aſcenſion* or *Deſcenſion*, is that which is in a Right Sphere.

11. In a Right Sphere, the four Quadrants of the Zodiack beginning from the Æquinoctial and Solſtitial Points, do equally Aſcend and Deſcend, ſo that in theſe whole Quadrants, as many Degrees of the Æquator as of the Zodiack do Aſcend; but the intermediate parts of thoſe Quadrants in the Zodiack do vary, and have not equal Aſcenſion and Deſcenſion with the parts of the Æquator.

12. Thoſe Signs that are equally diſtant from any of thoſe Points, have alſo equal Aſcenſion, as *Gemini* and *Cancer*. And the Aſcenſion of a Sign is always equal to the Deſcenſion of the ſame.

13. In a Right Sphere therefore, four Signs only do riſe Right, all the reſt do riſe Obliquely.

14. In an Oblique Sphere, the two halves that begin at the two Æquinoctial Points, do riſe together, but the parts of thoſe halves do riſe Obliquely. And thoſe Signs that riſe Rightly, do Deſcend Obliquely, and the contrary.

15. The Aſcenſion of oppoſite Signs in an Oblique Sphere, taken together, are equal to the Aſcenſion of the ſame in a Right Sphere. And thoſe ſigns that are equall diſtant from either of the Æquinoctial Points, have equal Aſcenſions, becauſe they equally Decline from the Æquator.

16. Beſides the Aſtronomical Riſing and ſetting of the ſtars, or their riſing and ſetting, in reſpect of the Horizon and Æquator, there are other affections of the ſtars to be conſidered, namely, thoſe which they have in reſpect of the ſun.

17. In reſpect of the Celeſtial Circles, that is in reſpect of the Zodiack, Æquator, and Horizon, there is a fourfold affection of the ſtars. 1. *Longitude*. 2. Of *Altitude*. 3. Of *Latitude*. 4. Of *Declination*.

18. The *Longitude* of a ſtar is his diſtance from the firſt Degree or Point of *Aries*, accounting from Weſt to Eaſt.

19. The *Altitude* of a ſtar is to be conſidered generally or ſpecially. Generally conſidered

ſidered, the Altitude of a ſtar is the height thereof above the Circle of the Horizon.

20. Specially conſidered, the Elevation of the Pole ſtar above the Horizon, is called the Altitude.

21. The *Latitude* of a ſtar is his Diſtance from the Ecliptick, that is from the very middle of the Zodiack towards either Pole, whether North or South.

22. The *Declination* of a ſtar, is his Diſtance from the Æquator, and as he declines from thence either Northward or Southward, ſo is his Declination nominated either North or South.

23. Thus much of theſe affections of the ſtars, which they have in reſpect of the Celeſtial Circles; come we now to thoſe which they have in reſpect of the ſun; uſually called the Poetical riſing and ſetting; and this is threefold. The firſt of theſe in *Latin*, is called *Ortus Matutinus ſive Coſmicus*, The Morning or Coſmical Riſing. The ſecond, *Veſpertinus ſive* Achronicus, The Evening or Achronical; and the laſt, *Heliacus vel Solaris*, Heliacal or Solary.

24. The Coſmical or Morning Riſing of a ſtar, is when it Riſeth above the Horizon, together with the ſun. And the Coſmical or Morning ſetting of a ſtar is, when it ſetteth at the oppoſite part of Heaven, when the ſun riſeth.

25. The *Achronical*, or Evening Riſing of

a Star, is when it Riseth on the opposite part, when the Sun setteth; And the Achronical Evening setting of a Star, is when it setteth at the same time with the Sun.

26. The *Heliacal* Rising of a Star, which you may properly call the Emersion of it, is when a Star that was hid by the Sun beams, beginneth to recover it self out, and to appear. And so likewise, the setting of such a star, which may be also called the Occultation of the same, is when the Sun by his own proper motion overtaketh any star, and by the brightness of his beams doth make it invisible unto us.

And thus having briefly shewed the chief affections of the Primum Mobile; how the quantity of these affections may be computed, by the Doctrine of Spherical Triangles, shall be declared in the Problems following.

Problem I.

To find the Suns Greatest Declination and the Poles Elevation.

In *Fig.* 9. *A Z*, *B N* represents the Meridian, *E F* the Æquinoctial, *H R* the Zodiack, *P* the North Pole; *O*, the South; *A B*, the Horizon; *Z*, the Zenith; *N*, the Nadir; *H C*, a Parallel; of the Suns Diurnal Motion at *H*, or the Suns greatest Declination from the Æquator towards the North Pole;

R Q, a Parallel of the Suns greateſt Declination from the Æquator towards the South Pole. From whence it is apparent, that from *A* to *H*, is the Suns greateſt Meridian Altitude, from *A* to *Q*, his leaſt; if therefore you deduct *A Q*, the leaſt Meridian Altitude, from *A H*, the greateſt, the Difference will be *H Q*, the Suns greateſt Declination on both ſides the Æquator; and becauſe the Angles *E D H*, and *F D R*, are equal, therefore the Suns greateſt Declination towards the South Pole is equal to his greateſt Declination towards the North, and conſequently, half the Diſtance of the Tropicks; that is, *E Q*, or *E H*, is the quantity of the Suns greateſt Declination; and then if you deduct the Suns greateſt Declination, or the Arch *H E*, from the Suns greateſt Meridian Altitude, or the Arch *A H*, the Difference will be *A E*, the height of the Æquator above the Horizon, the Complement whereof to a Quadrant, is the Arch *A O* equal to *B P*, the height of the Pole.

Example.

The Suns greateſt Meridian Altitude, taken *June* the Eleventh at *London.*	61.99167
The Suns leaſt Meridian Altitude *December* the tenth	14.94167

Their *Difference* is the distance of the *Tropicks*. ——— 47.05000

Half that is the Suns greatest Declination whose difference from the Suns least Meridian Altitude, is ——— 23.52500

The Elevation of the Æquator and the Complement thereof to 90, is the Elevation of the Pole--- 38.46667 51.53333

Problem II.

The Suns greatest Declination being given, to find his Declination in any point of the Ecliptick.

In *Fig.* 9. In the Right Angled Spherical Triangle *G L D*, we have given the suns greatest Declination *G D L*, and the suns distance from the next Æquinoctial point *L D*, to find the present Declination *G L*, for which the Proportion is *Rad. s L D :: s D. s G L.*

Problem III.

The suns greatest declination and his distance from the next Equinoctial point given, to find his Right Ascension.

In *Fig.* 9. In the Right Spherical Triangle *G D L*, we have given as before the Angle, *G D L*, and the Hypotenuse *D L*, to find the

the suns Right Ascension *D G*; the Proportion is *Rad*. *t D L* :: *c s D* . *t D* G.

Problem IV.

The Elevation of the Pole, and declination of the sun being given, to find his Amplitude.

In *Fig*. 9. In the Right Angled spherical Triangle *D T V*, we have given the Complement of the Poles Elevation or Angle *V D T*, and the suns declination *V T*, to find *D T*, the suns Amplitude; for which the Proportion is; *s V D T* . *Rad*. :: *s V T* . *s D T*.

Problem V.

The Poles Elevation and suns declination being given, to find the ascentional difference.

In *Fig*. 9. In the Right Angled spherical triangle *D V T*, we have given the Complement of the Poles Elevation, or Angle *V D T*, and suns declination *V T*, to find the Ascensional Difference *D V*; the Proportion is, *t V D T* . *Rad*. :: *t V T* . *s D V*.

Problem

Problem VI.

The right aſcenſion, and aſcenſional difference being given, to find the Oblique aſcenſion and declination.

In *Fig.* 9. *G V*, repreſents the right Aſcenſion; *D V*, the Aſcenſional difference; *G D*, the Oblique Aſcenſion, which is found by deducting the Aſcenſional difference *D V*, from the Right Aſcenſion *G V*; for if the Declination be North,

Add	The Aſcenſional diff. to	Obl.	Aſc.
Sub.	or from the right Aſcen. and it will give		Deſc.

If the Declination be South,

Sub.	The Aſcenſional diff. to	Obl.	Aſcen.
Add	or from the right Aſcen. and it will give		Deſce.

Problem VII.

To find the time of the Suns riſing and ſetting with the Length of the day and Night.

Firſt find the Aſcenſional difference, as hath been ſhewed in the fifth Problem; which, when the Sun is in the Northern ſigns,

ſigns, is to be added to the Semi-diurnal Arch of the Right ſphere, which is 90, but is to be ſubtracted from the ſame, if he be in the ſouthern ſigns, and the ſum or difference will be the ſemi-diurnal Arch, which doubled, is the day Arch, whoſe Complement to 24, is the night Arch, which Biſected, is the time of the ſuns riſing.

Problem VIII.

The Poles Elevation, and the ſuns Declination given, to find the time when he will be due Eaſt and Weſt.

In *Fig.* 10. In the Right Angled ſpherical Triangle *T P Z*, we have given *P Z*, the Complement of the Poles Elevation, and *TP*, the Complement of the ſuns declination, to find the Angle *T P Z*, for which the Proportion is, *Rad. . t P Z :: ct TP . cs T P Z.* whoſe Complement to a Quadrant *T* P D, being converted into time, ſheweth how much it is after ſix in the Morning, when the ſun will be due Eaſt, and before ſix at night, when he will be due Weſt.

Problem IX.

The Poles Elevation, with the Suns Altitude and Declination given, to find the Suns Azimuth.

In *Fig.* 10. In the Oblique Angled ſpherical Triangle *S P Z*, we have given *S P* the Complement of the ſuns declination, *R Z* the Complement of the Poles Elevation, and *S Z* the Complement of the ſuns Altitude, to find the Angle *S Z P*, the ſuns Azimuth from the North; for which by the eleventh caſe of Oblique Angled ſpherical Triangles, the Proportion is; As the Rectangle of the ſines of *S Z*, and *Z P*, is to the ſquare of Radius, ſo the Rectangle made of ſines of the differences of thoſe containing ſides and half ſum of three ſides given, to the Square of the ſine of the half angle inquired.

CHAP. IV.

Of the Secundary or Periodical Motion of the Stars.

Having done with the firſt part of *Aſtronomy*, the motion of the *Primum Mobile*, and the affections of the ſtars, occaſioned by that motion; we are now to ſpeak of their own

own Proper or Periodical motion; in which contrary to the motion of the *Primum Mobile*, they are carried from West to *East*.

2. This motion of the fixed ſtars is very ſlow; for they alter their places but little in many Years, but are not immoveable as ſome thought; the quantity of their annual motion, according to *Tycho Brahe* is 50 ſeconds, and 37 thirds of a degree, and others ſince him do conceive that 50 ſeconds only is the quantity of their annual motion, that is moſt agreeable unto truth and obſervation.

3. This motion in the Planets is more ſwift, and although they never move out of the Zodiack, yet they do move ſometimes in one part of Heaven, ſometimes in another, ſometimes towards the ſouth Pole, ſometimes towards the North, ſometimes near one fixed ſtar, ſometimes near another, and ſometimes nearer, ſometimes farther from one another alſo, whereas the fixed ſtars do always keep the ſame *diſtance* from one another.

4. The Planets do not move in one Orb, but every Planet hath a ſeveral Orb, whereas the infinite number of fixed ſtars do all move in one only ſphere or Orb.

5. The Names and Characters of the planets are theſe:

1. *Saturn*, whoſe mark is ♄, finiſheth his revolution in 29 Years, 174 Days, 4 Hours.

2. *Jupiter*, whoſe mark is ♃, finiſheth his Revolution in 11 Years, 317 Days, 15 Hours.

3. *Mars*,

3. *Mars*, whose mark is ♂, finisheth his Revolution in 1 Year, 321 Days, 23 Hours.

4. The *Earth* or *Sun*, marked thus ☉, finisheth his Course in 365 Days, 5 Hours, 49 Minutes, 4 seconds, and 21 thirds.

5. The *Moon*, marked thus ☽, finisheth her Course in 27 Days, 7 Hours, 43 Minutes, and 6 seconds, but returneth not into Conjunction with the *Sun*, under 29 Days, 12 Hours, 44 minutes, and 3 seconds.

6. *Venus*, marked thus ♀, finisheth her Course in 224 Days, 16 Hours, 40′ and 30″.

7. *Mercury*, marked thus ☿, finisheth his Course in 87 Days, 23 Hours, 00′ and 15″.

6. The Civil Year, though it doth not exactly agree, yet hath it some proportion with the Motions of the sun and Moon in every Nation; *Romulus* the founder of *Rome*, appointed the year at first to consist of 10 Moons, or Months, and called the first *March*, 2. *April*, 3. *May*, 4. *June*, the rest *Quintilis*, *Sextilis*, *September*, *October*, *November*, *December*, because they were 5, 6, 7, 8, 9, and 10 Months distant from *March*.

After whom, *Numa Pompilius* added two Months more, and called them *January* and *February*, and appointed each Month to contain 29 and 30 Days, whereby the Year did consist of 354 Days, in which time the Moon returneth into Conjunction with the Sun, and this is the quantity of the Year in *Turky* at

at this day; only in every third Year, they reckon 355 days. *The Persians* and *Ægyptians* do also count 12 Moons or Months to their Year, but their Months are proportioned to the time of the Suns continuance in every of the 12 signs: In their Year therefore, which is solar, there are always 365 days, that is, 11 days more than the Lunar Year.

And the *Julian* Year, which is the accompt of all *Christendom*, doth differ from the other only in this, that by reason of the suns excess in motion above 365 days, which is about 5 Hours, 49 Minutes, it hath a day intercalated once in four Years, and by reason of this Intercalation, it is more agreeable with the motion of the Sun, the former differing from the *Numan* Year, 11 days and 6 Hours, the which 11 days, *Julius Cæsar* distributed amongst the Months, and the month *Quintilis*, was by him called *July*, according to his own name; and *Augustus Cæsar* called the Month *Sextilis*, by the name of *August*, and altered the Position of days in each month to that which we now use, in which there are 52 Weeks, and one odd day, and this one day supernumerary, maketh an alteration in all the rest, so that the days of the Week, which used to be assigned by the Letters of the Alphabet, fall not alike in several Years; but *Sunday* this Year, must fall out upon the next years *Monday*, & so forward,

seven years; and because the six odd Hours do make a day in four years, every fourth year hath a day added to its accompt, and such a year doth consist of 366 days, which doth occasion the *Sunday* letter still to alter till four times 7, that is, 28 Years be gone about. This Revolution is called the *Cycle* of the Sun, taking name from ☉, *Sunday*, the Letter whereof it doth appoint for every year, as by the Table may be seen.

To find which of 28 the present is, add 9 to the Year of Our Lord, because this Circle was so far gone about at that the time of *Christ's birth*, divide the whole by 28, what remains, is the present year; if nothing remain, the *Cycle* is out, and that year you must call the last, or 28.

This Intercalation of a day, placed in *February*, doth occasion the letter *F* to be twice repeated in the latter end of that Month, *viz.* upon the 24 and 25 days, and in such a year St. *Matthias* day is to be observed upon the 25 of that month, and the very next *Sunday* doth change and alter his letter, from which Leaping or Changing, such a year is called the *Leap Year*, and the Number of days in each Month is well expressed in these Distichs.

Thirty

Thirty Days hath September,
April, June, *and* November;
February *hath Twenty Eight alone,*
All the reſt hath Thirty and One:
——*But when of Leap Year cometh the time,*
Then Days hath February *Twenty & Nine.*

That this Accompt is ſomewhat too long, is acknowledged and confeſſed by the moſt skilful *Aſtronomers*, as for the Number of days in a year, the Emperours Mathematicians were in the right, for it is certain, no Year can conſiſt of more than 365 days, but for the odd Hours, it is as certain that they cannot be fewer than five, nor ſo many as ſix, ſo that the doubt is upon the minutes, ſixty whereof goeth to the making of an Hour; a ſmall matter one would think, and how great in the receſs and conſequence we ſhall ſee.

Julius Caſar alotted 365 days, 6 hours, to his Revolution; but the Sun goeth about in leſs time, that is, (according to the moſt exact accompt,) in 365 days, 5 hours, 49 Minutes, and a little more; ſo that the Emperours year muſt of neceſſity breed a difference in ſo many Minutes every year, betwixt the year which the Sun it ſelf deſcribes in the Zodiack, and that which is reckoned upon in the Calender, which though for a year or two may paſs inſenſibly, yet in the ſpace of 134 years it will riſe to a whole day.

that is, the beginning of the year in the Calender must be set one day back.

As for Example.

Let the Year begin in the Vernal Æquinox, or Spring, in the Emperours time, that fell out to be the 24*th* of *March*, but now this year it fell out the 10*th* of *March*, 13 days backward and somewhat more; and so if it be let alone, will go back to the first of *March*, and first of *February*, till Easter come to be on *Christmas* day, and so infinitely.

To reform this difference in the accompt, some of the latter *Roman* Bishops earnestly endeavoured, and the thing was brought to that perfection it now standeth, (so much as it is,) by *Gregory* the Thirteenth, in the year 1582. his Mathematicians, (whereof *Lylius* was the chief) advised him thus: That considering there had been in agitation in the Council of *Nice*, somewhat concerned in this matter upon the motion of the Question about the Celebration of *Easter*; and that the Fathers of that Assembly, after due deliberation with the Astronomers of that time, had fixed the Vernal Æquinox, at the 21*th* of *March*, and considering also, that since that time a difference of 10 whole days had been past over in the Calender, that is, that the Vernal Equinox or Spring, which began upon the 21*th* of *March*, had prevented so much as to begin in *Gregories* days

days, at the 10th of the same, 10 days difference, or thereabout; they advised, that 10 days should be cut off from the Calender, which was done, and the 10 days taken out of *October*, in the Year 1582, as being the Month of that Year in which the Pope was born, so that when they came to the 5th of the Month, they reckoned the 15th, and so the Æquinox was come up to its place again, and happened upon the 21th of *March*, as at the Council of *Nice*. But that *Lylius* should bring back the beginning of the year to the time of the *Nicene* Council, and no farther is to be marvelled at; he should have brought it back to the Emperours own time, where the mistake was first entred; and instead of 10, cut off 13 days; however this is the reason why these two Calenders differ the space of 10 days one from another.

And thus I have given you an accompt of the year as it now stands with us in *England*, and with the rest of the *Christian* World, in respect of the Sun; some other particulars there are with us and them, that do depend upon the motion of the moon, for the better understanding of them, I will give you a brief accompt of her Revolution.

The Solar year consisting, as hath been said, of 11 days more than the Lunar year; those 11 days called the Epact, are therefore added to the Lunar Year, to made it e-

qual with the Solar, by the addition of which acceſs, in every three years there is gotten a number more than 30, but becauſe the Moon between change and change doth never paſs 30 days, the Epact cannot exceed that number, and the time in which the Moon is ſuppoſed to make her ſeveral Motions and ſo return to the place where ſhe firſt began, is a circle or Revolution of 19 years, firſt found out by *Meton*, an *Athenian*, who lived about 439 years before *Chriſt*, this Cycle is therefore called *Cyclus Decennovennalis*, and from the *Autor Annus Metonicus*, from whoſe *Athenians*, the *Ægyptians* may ſeem to have receiv'd it, as the *Romans* from them, in letters of Gold, from whence (if not from the more precious uſe of it) it attained to be called, as yet ſtill it is, the *Numerus Aureus*, or Golden Number: It is made *Chriſtian*, by the Fathers of the *Nicene* Council, as being altogether neceſſary to the finding out of the *Neomenea Paſchalis*, upon which the Feaſt of *Eaſter* and all the reſt of the moveable Feaſts depend: It ſelf is found by adding a Unite to the year of our Lord, and dividing the whole by 19, the Remainder ſhall be the Cycle of the Moon, or if nothing remain, the Cycle is out, that is, 19.

And the Epact is found by Multiplying the golden Number by 11, and dividing the Product by 30, what remains is the *Epact*; but to ſave this trouble of *Calculation*, you have it ſet down to your hand in the table before the Calender

lender, the use whereof as of the Golden Number is to find the Change of the Moon, for the Ancient Philosophers supposing the Moon to make a perfect *Revolution* in 19 years, did Calculate the several Changings of the Moon that happened in each Month for that time, and placed the golden number for each year, right against the day of the Month on which the Moon changed, that so having found the *golden number*, they might thereby presently know on what day of the *month* the Moon did change, in any Month of the year for ever, as also the time, when the Feast of *Easter* was to be observed, according to the Canon made at a General Council held at *Nice*, in the year of our Lord, 322, in which it is *commanded* that *Easter* should be Celebrated *upon* the next *Sunday following* the first Full Moon after the Vernal Æquinox, which then was upon the 21*th* day of *March*, and according to this rule is this *Feast* observed with us at this day, and not according to the *true* Motion of the Moon, or precise time of the Vernal Æquinox, which now is about the 10*th* of *March*; This use of the Golden Number is well expressed in these Distichs.

In March *after the first* C,
Look the Prime *where e're it be*;
The third Sunday *after* Easter *day shall be*,
And if the Prime *on the* Sunday *be*,
Then reckon that for one of the three.

To

To find the New Moons by the Epact, do thus, To the Epact for the year given add the number of the months from *March* including both Months, and the days of that Month past, the Sum of these three Numbers shall give you the age of the Moon, if they exceed not 30, if more than 30, cast away 30, and the Remainder shall be the Age as before.

Example.

I would know the Age of the Moon on the Fifteenth day of *August*, 1672. The Epact is 11, and the Months from *March* to *August* are 6, and 15 the day of the Month, all which put together, do make 32, from whence take 30, and there rests 2, the Age of the Moon that day.

And to know the day of the Change, do thus: To the Epact add all the months from *March*, and if they joyned together, come not to 30, look what they lack of 30, and at so many days of the month the moon changeth: If they be above 30, and the month you desire have 31 days, then Subtract 30; but if 30 days, then Subtract 29, and that rest take from 30, then look what remains, and at so many days of the month the moon changeth, by either of these ways the time of the new moons may indeed be guest at, but not exactly found: How that may be done, is shewed in the larger Treatises of this Subject; this we deem sufficient for our present purpose.

A

A Table, shewing the Cycle of the Suns, Dominical Letter, Golden Number, and the Epact.

Year of our Lord.	Cycl. ⊙	Dom. Lett.
1672	1	G F
1673	2	E
1674	3	D
1675	4	C
1676	5	B A
1677	6	G
1678	7	F
1679	8	E
1680	9	D C
1681	10	B
1682	11	A
1683	12	G
1684	13	F E
1685	14	D
1686	15	C
1687	16	B
1688	17	A G
1689	18	F
1690	19	E
1691	20	D
1692	21	C B
1693	22	A
1694	23	G
1695	24	F
1696	25	E D
1697	26	C
1698	27	B

Year of our Lord.	Golden Number.	Epact.
1672	1	11
1673	2	22
1674	3	3
1675	4	14
1676	5	25
1677	6	6
1678	7	17
1679	8	28
1680	9	9
1681	10	20
1682	11	21
1683	12	12
1684	13	23
1685	14	4
1686	15	15
1687	16	26
1688	17	7
1689	18	18
1690	19	29

	January.	Febr uary.	March.
1	3 *a* Circum.	*d*	3 *d* David.
2	*b*	11 *e* Purifica.	*e*
3	11 *c*	19 *f*	11 *f*
4	*d*	8 *g*	*g*
5	19 *e*	*a*	19 *a*
6	8 *f* Epipha.	16 *b*	8 *b*
7	*g*	5 *c*	*c*
8	16 *a*	*d*	16 *d*
9	5 *b*	13 *e*	5 *e*
10	*c*	2 *f*	*f*
11	13 *d*	*g*	13 *g*
12	2 *e*	10 *a*	2 *a*
13	*f*	*b*	*b*
14	10 *g*	*c* Valent.	10 *c*
15	*a*	18 *d*	*d*
16	18 *b*	7 *e*	18 *e*
17	7 *c*	*f*	7 *f*
18	*d*	15 *g*	*g*
19	15 *e*	4 *a*	15 *a*
20	4 *f*	*b*	4 *b*
21	*g*	12 *c*	*c*
22	12 *a*	1 *d*	12 *d*
23	1 *b*	*e*	1 *e*
24	*c*	5 *f*	*f*
25	9 *d*	17 *g* S.Math.	9 *g* Annun.
26	*e*	*a*	*a*
27	17 *f*	6 *b*	17 *b*
28	6 *g*	14 *c*	6 *c*
29	*a*		*d*
30	13 *b*		14 *e*
31	3 *c*		3 *f*

	April.		May		June.	
1		g	11	b Philip &		e
2	11	a		c Jacob.	19	f
3		b	19	d	8	g
4	19	c	8	e	16	a
5	8	d		f	5	b
6	16	e	16	g		c
7	5	f	5	a	13	d
8		g		b	2	e
9	13	a	13	c		f
10	2	b	2	d	10	g
11		c		e		a
12	10	d	10	f	18	b
13		e		g	7	c
14	18	f	18	a		d
15	7	g	7	b	15	e
16		a		c	4	f
17	15	b	15	d		g
18	4	c	4	e	12	a
19		d		f	1	b
20	12	e	12	g		c
21	1	f	1	a	9	d
22		g		b		e
23	9	a	9	c	17	f
24		b		d	6	g Jo. Bapt.
25	17	c S. Mark.	17	e		a
26	6	d	6	f	14	b
27		e		g	3	c
28	14	f	14	a		d
29	3	g	3	b	11	e Pet. Ap.
30		a		c		f
31			11	d		

	July.		August.		September.
1	19 g		8 c Lammas.		16 f
2	8 a		16 d		5 g
3	b		5 e		a
4	16 c		f		13 b
5	5 d		13 g		2 c
6	e		2 a		d
7	13 f		b		10 e
8	2 g		10 c		18 f
9	a		d		7 g
10	10 b		18 e		a
11	c		7 f		15 b
12	18 d		g		4 c
13	7 e		15 a		d
14	f		4 b		12 e
15	15 g		c		1 f
16	4 a		12 d		g
17	b		1 e		9 a
18	12 c		f		b
19	1 d		9 g		17 c
20	e		a		6 d
21	9 f		17 b		e St. Mat.
22	g		6 c		14 f
23	17 a		d		3 g
24	6 b		14 e S. Bar-		a
25	c Jam. Ap.		3 f tholo.		11 b
26	13 d		g		19 c
27	3 e		11 a		d
28	f		b		8 e
29	11 g		19 c		f S. Mich.
30	a		8 d		g
31	19 b		e		

	October.	November.	December.
1	16 a	d All Sain.	f
2	5 b	13 e	13 g
3	13 c	2 f	2 a
4	2 d	g	10 b
5	e	10 a	c
6	10 f	b	18 d
7	g	18 c	7 e
8	18 a	7 d	f
9	7 b	e	15 g
10	c	15 f	4 a
11	15 d	4 g	b
12	4 e	a	12 c
13	f	12 b	1 d
14	12 g	1 c	e
15	1 a	d	9 f
16	b	9 c	g
17	9 c	f	17 a
18	d	17 g	6 b
19	17 e	6 a	c
20	6 f	b	14 d
21	g	14 c	3 e S. Tho.
22	14 a	3 d	f
23	3 b	e	11 g
24	c	11 f	a
25	11 d	19 g	19 b Christm.
26	e	a	8 c S. Steve.
27	19 f	8 b	d S. John.
28	3 g Simon	c	16 e Innoce.
29	a & Jude	16 d	5 f
30	16 b	5 e Andrew	g
31	5 c		13 a

THE *ENGLISH* ACADEMY:

The SIXTH PART.

Of RHETORICK.

CHAP. I.

Of the Definition and Parts of RHETORICK.

RHETORICK, is the Art or faculty of Eloquent and delightful Speaking.

The Parts of *Rhetorick* are Five; *Invention*, *Disposition*, *Elocution*, *Memory*, and *Pronounciation*.

In *Invention*, we are to consider three things:

1. What we are to Invent. 2. By what Arguments we may confirm the Matter Invented. 3. From what Topicks or general

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ral Heads thoſe Arguments may be raiſed.

And firſt, the thing or matter which we are to invent, is the ſcope and purpoſe of the intended Oration: That is, we muſt propound ſome certain Propoſition to which we mean to direct our Speech; and of thoſe ſeveral Propoſitions which may be raiſed from the ſubject propounded, we ſhould ſtill make choice of that which is moſt agreeable to the Sentence given.

Secondly, When we have reſolved upon a Propoſition, we are to bethink our ſelves of ſome Arguments or probable Reaſons, by which that Propoſition may be confirmed.

Thirdly, We are to conſider the ſeveral Topicks or common places from whence theſe probable Arguments may be invented and raiſed, and theſe are of two ſorts; *Intrinſecal* and *Extrinſecal*; thoſe that are called *Intrinſecal*, which are compriſed in the matter which is propounded, and the Topicks or Heads, from whence ſuch Arguments may be invented, are theſe following.

1. *Definition.* 2. *Diviſion.* 3. *Notation.* 4. *Conjugation.* 5. *Genus.* 6. *Species.* 7. *Similitude.* 8. *Diſſimilitude.* 9. *Contraries.* 10. *Oppoſites.* 11. *Compariſon.* 12. *Cauſes.* 13. *Effects.* 14. *Adjuncts.* 15. *Antecedents.* 16. *Conſequents.* All other *Topicks*, from whence Intrinſecal or Artificial Arguments may be raiſed, are contained in theſe, or may be derived from them.

1. *Definition.*

1. *Definition*, is a Speech explaining or declaring what a thing is; The parts whereof, according to Logicians are two; 1. The *Genus*, or general name agreeing with the thing defined, and with several other things besides. 2. The difference or particular name, which doth only agree with that which is defined:

For Example.

Man is a Living Creature, endued with Reason. In which the *Genus* is living Creature; and this agrees with other Creatures besides Man; the Difference, is endued with Reason, and this is proper to Man only. But such Definitions as these, are seldom used by Orators, but such rather as are called Descriptions, more properly than Definitions; as when a thing is described by its parts, or by its effects, or by the causes by which effects are produced, and such like.

2. *Division*, is the distribution of the matter propounded into its parts; Thus the Life of Man may be divided into Infancy, Child-hood, Youth, Middle-age, Old-age.

3. *Notation*, or *Etymologie*, is the Interpretation of a Word, shewing as well the Original thereof, as the Signification; As a *Senate* is so called from the convention of the Seniors or Old Men.

4. *Conjugation*, is either when one word hath various endings; as *knife*, *knives*; or

when ſeveral words do come from one Primitive, thus; *beautiful* and *beautifulneſs*, are both derived from *beauty*.

5. A *Genus*, is that which comprehends ſeveral things under it; which are really different from one another.

6. A *Species*, is that which may with other things be referred to one common *Genus*: And thus this word *Art*, is a *genus*, in reſpect of the ſeven Liberal Sciences; as *Grammar*; *Rhetorick*, &c. and theſe Sciences *Grammar*, *Rhetorick*, &c. are the Forms and *Species* which are contained under this *Genus* or general term, *Art*.

7. *Similitude*, is the comparing of two or more *things* together, which are in *themſelves* divers, but do agree in ſome particular.

For Example.

A *ſhadow* and *glory*, are in themſelves very different things; but yet they agree in this, that the *ſhadow* doth accompany the *body*, and *glory*, *virtue*.

8. *Diſſimilitude*, is the diſagreeing of two or more things in ſome particular.

9. *Contraries*, are ſuch things which cannot both at the ſame time, agree with one & the ſame thing: Thus no man can be ſaid to be wiſe in that thing in which he is a Fool.

10. *Oppoſites*, are ſuch things as can never agree together, as *wrath* and *friendſhip*.

11. *Compariſon*, is the comparing of one thing

thing with another; This is either equal or unequal.

Equal Comparison is, when two equal things are compared together; as thus, *He hath deceived thee, therefore he will deceive me also.*

Unequal Comparison, is two ways, first, when we argue from the greater to the less: As *God spared not the Angels that sinned, how then shall He spare Man?*

Secondly, when we argue from the less to the greater; As, *He will not let one sin go unpunished; much more will he therefore punish a multitude of sins.*

12. *Causes*, are such things by which any thing is in any sort produced; there are Four sorts of *Causes*; *Efficient*, *Material*, *Formal*, and *Final*.

The *Efficient cause*, is that which *maketh* a thing: Thus the Sun causeth or maketh the day.

The *Material cause*, is that of which a thing is made; as *Money*, of *Gold* and *Silver*, &c.

The *Formal cause*, is that by which the thing is what it is, or that by which it is distinguished from other things; thus a *Ship* and a *Timber-house* do differ in the form, or divers disposing of the parts.

The *Final cause*, is that for which a thing is made.

13. *Effects*, are such things as are propounded by their causes. 14. *Adjuncts.*

14. *Adjuncts*, are such things which are joyned to the thing or person propounded, but not of necessity; and these are usually seven.

Quis? Quid? Ubi? Quibus Auxiliis? Cur? Quomodo? Quando?

In English thus,

First ask, Who? What? and Where? and Then, What aid? with Why? and How? and When?

Quis? Who? doth signifie the quality of the Person, in which there must be considered his Nature, Sex, Age, Nation, Kindred, and Estate, in respect of his Body, Mind, and Fortune.

Quid? What? importeth an Inquiry after the nature of a thing, as whether it be of importance or not; whether great or small; noble or ignoble.

Ubi? Where? denotes the place.

Quibus Auxiliis? VVith what aid? notes an inquiry concerning the person that joyned with him in that action, or other Instruments by which it is effected.

Cur? VVhy? denotes the final cause, with what intent, or to what end it was done.

Quomodo? How? shews the manner of doing it; as namely, with ease, or how hardly.

Quando? When? notes the time in which it was done, and this head doth many times afford great plenty of matter.

15. *Antecedents*, are such things which go before the thing or matter; as you made him,

him tremble, therefore he is ſenſible.

16. *Conſequents*, are ſuch things which do neceſſary follow after the thing or matter as he that is thruſt through the heart, muſt needs die; theſe are the Intrinſecal or Artificial *Topicks*, from whence Arguments may be raiſed on any Theme or matter propounded in this manner.

Every Theme or Propoſition doth conſiſt of three parts; a *Subject*, a *Predicate*, and a *Copula*.

That is called the *Subject*, of which we ſpeak; The *Predicate*, is that which is ſpoken of the Subject; and the *Copula*, is ſome Verb, which joyns the Subject with the Predicate, as in this Propoſition; Claudius *laid ſnares for* Milo: *Claudius* is the Subject, becauſe it is of him that we are to ſpeak. *Snares for* Milo, is the Predicate; becauſe that is the thing which is ſaid of *Claudius*. And the Verb *laid*, is the Copula, which joyns the Subject with the Predicate. Now then if you will find out Arguments on this Propoſition, take the Subject and go through every Topick: firſt go to Definition, and ask what it is, what is the nature on't? and how it is *diſtinguiſhed* from other things? then go to Diviſion, and ſee into how many parts the Subject may be divided; and ſo forward from Topick to Topick. And ſtill obſerve to your ſelf every Argument, which doth by this means ariſe from the Subject,

and apply it to the Predicate; so shall you easily see, whether it doth fully confirm your Proposition, and when you have done with the Subject, take the Predicate, and run through the several Topicks with that also; but if the matter require it, and that you judge it more convenient to take the whole Proposition, then the Subject and Predicate a part by themselves, you may in that manner run through all the heads of Invention; but stay not too long upon any one, for if matter offer not it self in one head, go to another, for every head perhaps may not afford matter, at least not such as is apt and fit. But if you would know whether your Arguments or matter be drawn from the Subject, or from the Predicate, put it into the form of a Syllogism, and if the major be most certain, you may conclude, that the Argument is drawn from the predicate; but if the minor be most certain, it is then drawn from the Subject.

When you have found the Arguments which prove the Proposition, you must reduce them into the form of a Syllogism, which doth consist of three Propositions the first whereof is called the *Major*, the second the *Minor*, and the third the *Conclusion* or *Inference*.

For Example.

In the former Proposition, Claudius *laid snares for* Milo; the matter or Subject of the

Discourse

Discourse may be drawn from the Predicate *the snares laid for* Milo; which being a treacherous thing, every one may naturally infer, that it doth deserve punishment.

Now then joyn this Inference with the Predicate of your Proposition; saying, *He that layeth snares deserveth punishment*, and this is your *Major*; then take the Subject of your Proposition, and joyn that with the Predicate, and say, Claudius *layeth snares*, and that is your *Minor*: From both which, this conclusion must needs follow, *Therefore* Claudius *deserveth punishment*.

17. Hitherto we have spoken of Artificial Arguments, Inartificial are either Testimonies or Examples.

Testimonies are either Divine or Human, a Divine *Testimony*, is that which hath God for its Author; such are the Oracles of God, and the predictions of his Prophets.

Humane *Testimony*, is either Common or Proper.

Common *Testimony*, is that which depends either upon some Law, Custom, or Opinion and Sayings of wise Men.

Proper *Testimony*, is that which is peculiar to some particular Causes.

Example, is an Inartificial Argument, by which the truth of a thing is confirmed and illustrated.

CHAP. II.

Of Disposition.

Disposition, is the orderly placing of those things which are invented: It is two-fold.

First, *Natural*, in which things are discoursed in that order in which they were done, or in which according to Nature, they should be done; as if you were to commend a Person, you should begin with his Childhood, next his Youth, and so to the other degrees of his Age.

The second way is *Artificial*, which doth either for delight or profit diversly mingle and confound the matter, putting that in the end, which should be in the beginning, and the beginning in the end, that so he may both delight the Auditors, and hold them in suspense; which in an unexpected event doth not a little please and delight the Hearers.

The Orator then having resolved of his Proposition, must first consider of what nature it is, whether single, or consisting of several parts; and which of the parts should be first handled, which next.

Secondly, he must choose some few of the best Arguments he hath invented, and place some

ſome ſolid Argument in the beginning, thoſe that are leſs forcible in the midſt, reſerving ſtill the beſt and moſt convincing for the concluſion; becauſe the Auditor at the firſt being greedy of knowing, muſt be prepoſſeſſed and convinced; but in the end he muſt be ſtrongly confirmed and forced.

And the moſt perſwaſive Arguments are thoſe which proceed from the Definition, Diſtribution, *Genus*, Cauſes, and Effects of the thing diſcourſed of, for theſe explain the nature thereof; and leſs forcible Arguments are ſuch as are collected from ſome trivial Adjuncts and Conjectures.

Thirdly, he muſt Logically diſpoſe of theſe Reaſons and Arguments; Firſt, into Syllogiſms, and then conſider how to enlarge them in an Oratorical manner.

Fourthly, he muſt conſider into what parts his Oration ſhould be divided, and the parts of an Oration are uſually reckoned to be theſe five.

1. *Exordium.* 3. *Narration.*
2. *Propoſition.* 4. *Confirmation.*
5. *Peroration*, or *Concluſion.*

As for Confutation, it is compriſed in Confirmation: But all theſe parts are not always neceſſary; for the ingenious Orator, may as he ſhall ſee it convenient, ſometimes omit the *Narration*, ſometimes the *Exordi-*

um, sometimes the *Peroration* or *Conclusion*, yea, and the *Confirmation* is many times scarce discernable; as when the things propounded are certain, there is more need of Ornament than Proof, as in Gratulatory Orations, and the like. As for the placing of these parts, their natural Order is that in which we have named them. 1. The *Exordium*. 2. The *Proposition*. 3. The *Narration*, if it be not thought fit to omit it. 4. The *Confirmation*; and Lastly, The *Peroration*.

An *Exordium*, is as it were the door of the Oration, in which the Orator doth prepare the minds of the Auditor for that which is to follow: And this is commonly done by one of these three ways; By bespeaking their favour; by making them Docible; or by begging their Attention. The Favour of the Auditors is bespoke either from the person of the Orator, from the persons of the Auditors, from the persons of the Adversaries, or from the subject matter of the Discourse. The Orator may bespeak the Favour of the Auditors, in respect of himself, if his gesture and deportment be suitable unto theirs that are his Auditors, and express himself modestly. And in respect of the Auditors, if he shew how well they have deserved of the Common-wealth, of him, and other men. And in respect of the Adversaries, if he modestly shew wherein they

they are faulty, and render them to the Auditors inexcusable. And lastly, in respect of the matter in hand, if he say, that it is some excellent, necessary, and profitable thing.

Secondly, the Orator may be said to make the Auditors Docible, if he clearly explain the thing of which he is to speak, and how he purposeth to enlarge upon it.

Thirdly, the Attention will be quickened, if he saith, that he intends to speak of some great and wonderful thing, and something that is delightful, necessary, and very much concerns his Auditors, *&c.*

The second part of an Oration is the *Proposition*; and the *Proposition* is that part of the Oration, in which the Orator doth briefly deliver the sum of the whole Matter, of which he intends to speak, and bespeaks the Hearers Attention, if need be. Sometimes it doth immediately follow the *Exordium*; sometimes it follows the *Narration*; in what place soever it be put, it must be short and clear, and fit for *Confirmation.*

The third part of an Oration is *Narration*, by which a relation is made of the matter or thing done. And this is either a distinct part of the Oration, and then for the most part it doth immediately follow the *Exordium*, that the *Proposition* with the *Confirmation*, which is to be done in such Orations which assume the explaination of

the thing done to prove the matter in hand.

For Example.

If you were to prove that ſome Valiant Perſon had been a Souldier in ſome Warr it is neceſſary that you ſhould declare what the particular Actions were in which he ſhewed his Valour.

But now in that *Narration*, which is made a diſtinct part of the Oration; the thing done muſt be briefly and ſimply declared without any exaggregation: And in ſuch a *Narration* as makes way for *Confirmation*, the things done may be illuſtrated with great neatneſs of Language, with Sentences and Figures, and ſome Diſcourſes may be made concerning the worthineſs of the action, with ſome amplification from Similitudes and Compariſons.

The fourth part of an Oration, is *Confirmation*: and *Confirmation* is as it were the very Heart and Soul by which an Oration may be chiefly ſaid to Live: Or it is the chief part of an Oration in which the Arguments are produced, by which we would prove our *Propoſition*, and refute or anſwer the contrary opinion of our Adverſary, if need require. What is neceſſary in this behalf, may be collected from what hath been already ſaid. Seeing that *Confirmation* doth conſiſt of the Arguments that are invented and the right diſpoſition of them, both which have been fully enough declared before.

Confutation.

Confutation, is a part or kind of *Confirmation*, in which we Anſwer all Objections; it doth either precede or follow *Confirmation*, or may be here or there uſed in all the parts of the Oration.

And theſe objections may be either all Anſwered together, or thoſe firſt which are firſt made, and then the latter; or thoſe firſt which are moſt material, and the reſt may fall of themſelves; or the weakeſt firſt, that they being avoided, the ſtrongeſt Arguments may be ſomewhat weak'ned. And the manner of doing this, is by ſhewing, that the Adverſaries Allegation is either falſe, impoſſible, uncertain, or impertinent, and the like.

Peroration, or *Concluſion*, is the laſt part of an Oration, in which the Orator ſhould very much endeavour to ſet an edge in the minds of his Auditors, and incline them to be of his ſide; and here he ſhould therefore uſe ſuch Figures, as are moſt proper to move the Affections: It doth chiefly conſiſt of two parts, *Enumeration*, and *Amplification*.

Enumeration is required, that the chief Arguments more largely opened in the former diſcourſe may be clearly repeated in a new form of words.

Amplification, deſires that this repetition may be made, by ſome ſerious expreſſions, adorned with Sentences and Figures.

CHAP. III.

Of Elocution.

Elocution, or the garnishing of Speech, is an Art by which the Speech is beautified with the Elegancy of Words and Sentences.

And this is performed two ways; by the fine manners of Words, called a *Trope*; or by the fine frame of Speech, called a Figure.

A *Trope* is such an Elocution or manner of Speech, as doth change the signification of a word into a different signification from the natural.

In a *Trope* two things are to be considered. 1. The *Affections*. 2. The *Kinds*.

The *Affections* of a *Trope* are four,
- *Catachresis.*
- *Hyperbole.*
- *Matalepsis.*
- *Allegoria.*

Catachresis, is a harsh and unpleasant change of a Word; as namely, when one word or name is put to another, not by any proper relation, but by a kind of force. *He threatens me a good turn.*

Hyperbole, is a very high relation of a thing, or a more bold excess of a *Trope*, which doth exceed belief, either by Augmentation

tation or by Diminution. Note that though an *Hyperbole* doth vary from the truth, yet doth it not deceive us through Fiction, or such variation.

An *Hyperbole* is two-fold; *Auxesis* or *Meiosis*.

An *Auxesis* is, when for Argumentation sake or Amplification, we interpose a more vehement expression, in his proper place; as when we say, *magnificent* for *liberal*.

A *Meiosis*, or a *Tapinosis*, is when for extenuation sake, we use a milder or more favourable expression, than the matter requireth; as when we say *a flatterer is a courteous and an affable person*.

A *Matalepsis*, is that which containeth many Tropes in one expression; as, when we by an improper Speech, signifie, first, that which is improper, and by that improper Speech perhaps another, and so forward, till we come to that which is proper, making way for Transition, by interposing a mean degree; as *All the City was moved. Mat.* 21. 10. where the City is put for *Jerusalem*, by a *Synechdoche Generis*: and *Jerusalem* for its Inhabitants, by a Metonymy of the Subject.

An *Allegory*, is the continuation of a Trope as where many Tropes of the same kind are joyned together; as, *Put on the whole Armor of God, Ephesians* 6. 11.

In an *Allegory*, observe to end with the same kind of Trope with which you begin, or else

else the Consequence will be abused.

The several kinds of *Tropes* are these four:

1. A *Metonomy*. 3. A *Metaphor*; and
2. An *Irony*. 4. A *Synechdoche*.

A *Metonomy*, is a *Trope* of the Cause to the Effect, of the Subject to the Adjunct: and the contrary, of the Effect to the Cause, or of the Adjunct to the Subject.

There are four kinds of Causes.

1. *The Efficient Cause*, by which a thing is.

2. *The Material Cause*, of which a thing is made.

3. *The Formal Cause*, by which a thing is what it is.

4. *The Final Cause*, for which a thing is; of which the two first only belong to our present purpose.

A *Metonymy* of the *Cause*, is of the *Efficient*, or of the *Matter*.

A *Metonymy* of the *Efficient Cause*, is when the *Author* or Inventor of any thing is put for those things which he hath invented; as *Virgil*, for the Poem or *Works* composed by *Virgil*.

A Metonymy of the *Material Cause*, is when the name of the Matter is put for the Effect; as Brass, for Brass Money.

A Metonymy of the *Effect*, is when the Efficient Cause is signified by the Effect; as, *Pale Death*, which *maketh Pale*.

A

A *Metonymy* of the *Subject*, is when the proper name of any Subject is made to signifie the Adjunct; as, *the Cup*, for the *Drink in the Cup*.

A *Metonymy* of the *Adjunct*, is when the Adjunct is put for the Subject; as *Gen.* 31. 53. *Jacob swear by the fear of his Father Isaac*, *i. e.* by God, whom *Isaac* feared.

An *Irony*, is a Trope from one opposite to another, or in which we speak by contraries.

Opposites; are either unlike or contrary; all things of different natures are said to be unlike; as a *Man*, a *Stone*; and all things of contrary natures are said to be contrary to one another; as *light* and *darkness*.

An *Irony* of a thing unlike, is when any thing is spoken of one person, and understood of another.

An *Irony* from the contrary, is when one contrary is signified by another; as *O thou hast done very well*; meaning that he had *done very ill*.

Paralepsis, is a kind of *Irony*, by which we seem to pass by, or take no notice of such things which yet we strictly observe and remember.

Apophasis, is a kind of *Irony*, by which we deny to say or do what yet we speak with greatest earnestness, and do with all our might.

A *Metaphor*, is a Trope, by which we

expreſs our ſelves by a word, which is of the like ſignification with that we mean; as, *the King is the Head of the Common-wealth.*

Synecdoche, is a Trope, by which a part is put for the whole, or the whole for a part.

A Part, is either a Member or Species.

A Synecdoche of a Member, when by a Member the whole is ſignified; as, the *Roof* for the *Houſe.*

A Synecdoche of the *Species*, is when the *Species* is put for the *Genus*; as, *Crœſus*, for a *Rich man.*

The whole is either an *Integer* or *Genus.*

A Synecdoche of an *Integer*, is when an *Integer* is put for a Member; as, *His Army was ſo great, that it drank the Rivers dry*; meaning a great part of the Water in the River.

A Synecdoche of the *Genus* is, when the general is put for the ſpecial; as, *Preach the Goſpel to every Creature*, meaning Mankind only, and not to every Creature.

Hitherto of *Tropes*, the firſt kind of elocution, the ſecond kind of Elocution by Figure.

CHAP

CHAP. IV.

Of a Figure.

A *Figure*, is a kind of Elocution, by which the form of a Speech is changed from its right and plain use.

A Figure, is either of a Word, or of a Sentence.

A Figure of a Word, is that by which an Oration or Speech is compoſed of words aptly and ſweetly ſuitable to one another, and this conſiſts in the Dimenſion or Repetition of Sounds or VVords.

A Figure, in the Dimenſion of Sounds, is the ſweet number of Sounds in a Sentence.

Number, is either *Poetical* or *Oratorical*.

A Poetical Number, is that which is confined to a perpetual obſervation of certain Spaces.

A Number Poetical, is either *Rhyme* or *Meter*.

Rhyme is a *Poetical Number*, containing a certain number of Feet, without any regard to the quantity of the Syllables; whether long or ſhort, *As*,

Dare to be true; nothing can need a lye:
A fault that needs it moſt, grows two thereby.

A *Meter*, is a Poetical Number, conſiſting of

of certain Feet, of which the laſt Foot hath the laſt Syllable indifferent or common; that is, long or ſhort.

Oratorical Number doth indeed conſiſt of Feet, but not of any certain number of Feet, but of as many or as few as the Orator pleaſeth.

The *Figure* of a word in reſpect of the repetition thereof, is either of like or unlike Sounds.

A *Figure* of a word in the repitition of the like Sound, is either with, or without Intermiſſion.

Repetition of the like Sound without intermiſſion, is either an *Epizeuxis*, or an *Anadiploſis*.

An *Epizeuxis*, is when a like Sound is repeated in the ſame Sentence without Intermiſſion; as, *a ſword, a ſword is ſharpened.*

An *Anadiploſis*, is when a like ſound without Intermiſſion is repeated in divers ſentences, *i. e.* when it ends one and begins another; as,

If then, why I take not my leave, ſhe ask;
Ask her again, why ſhe did not unask?

Repetition of like ſound with intermiſſion in the ſame place, is either an *Anaphora* or *Epiſtrophe*.

An *Anaphora*, is when a like ſound is repeated

peated in the beginning of Sentences; as,

By art of Sails and Oars, Seas are divided:
By art the Chariot runs, by art Loues guided.

An *Epistrophe*, is when a like sound is repeated, in the close of sentences; as, *Are they* Hebrews? *so am I*: *Are they* Israelites? *so am I*: *Are they of the seed of* Abraham? *so am* I.

Repetition of like sound with intermission in divers parts or places, is either an *Epanalepsis*, or an *Epanados*.

An *Epanalepsis*, is when a like sound is repeated in the beginning and ending of the same Sentence; as, *In sorrow was I born, and I must dye in sorrow.*

An *Epanados*, is when the like sound is in the beginning and ending of divers sentences, an *Anadiplosis* coming between; as Parthenia *desired above all things to have* Argalus; Argalus *feared nothing but to miss* Parthenia.

A *Figure* of a Word made by the repetition of sounds somewhat unlike, is either *Paronomasia*, or *Polyptoton*.

Paronomasia, is when a Word being changed in a Letter or Syllable, it is also changed in sense and signification; as, *Though you advise me to repent, I have not Grace to follow your advise.*

A *Polyptoton*, is when words of the same

ginal are reiterated, but with ſome variation; as, *Deceiving*, and *being Deceived*.

A *Figure* in reference to a ſentence, is a Figure which affecteth the whole ſentence with ſome motion of the Mind, either in abſolute reaſoning, or in reaſoning Dialogue-wiſe.

Logiſmus, or abſolute Reaſoning, is when a ſentence is compoſed without any talking with other ſuppoſed; this is either *Ecphoneſis*, a *recalling of ones ſelf*, *Apoſtrophe*, or *Proſopopeia*.

Ecphoneſis, is a Figure in reaſoning, by way of Exclamation, by an Adverb expreſſed, or underſtood; as, *O wretched man that I am!*

Recalling of ones ſelf, is when ſomething is called back; and it is as it were a Diminution of the over-haſtineſs or heat of ſpeech; and this is either *Epanorthoſis*, or *Apoſiopeſis*.

An *Epanorthoſis*, is when ſomething precedeing is called back, by correcting it; as, *I had one only Young Man to my ſon; ah! what have I ſaid! I had! yea I had! It is now uncertain whether I have or not.*

An *Apoſiopeſis*, is when the cloſe of a ſentence begun is ſtopped, by keeping in a part, which yet is underſtood; as, *You Rogue if I Live!*

An *Apoſtrophe*, is when a ſpeech is directed to another, than was by the ſpeech it

ſelf

ſelf at firſt intended; as, *God knows I lye not.*

A *Proſopopœia*, is when in our Oration, we ſuppoſe another perſon to be ſpeaking; as, Joſh. 24. 27. *Behold this ſhall be a witneſs unto us; for it hath heard all the Words of the Lord, which he hath ſpoken unto us.*

A *Figure*, in reaſoning Dialogue-wiſe, is when a ſentence is compoſed in form of a Conference; this conſiſteth in Queſtion and Anſwer, in Conſenting or diſſenting Dialogiſm.

A *Figure* of conſenting Dialogiſm, is when ones Anſwer doth admit of the Objection expreſſed or underſtood; yet ſo, as that from thence the inconſequence of the Objection may be ſhewed if need be.

Diſſenting Dialogiſm, is when ones anſwer doth impugn or croſs the Objection.

And thus much concerning *Elocution*, as for *Memory* and *Pronounciation*, which are the other two parts of *Rhetorick*, I purpoſely omit them, as being natural Endowments, which may be better improved by conſtant practice, than by any Precepts which can be given.

FINIS.

THE *ENGLISH* ACADEMY:

The SEVENTH PART.

Of the ART of LOGICK.

CHAP. I.

Of Simple Themes.

1. *Logick* is an Art which conducteth the Mind in the knowledge of Things.

2. The Parts of *Logick* are two, *Thematical* and *Organical.*

3. The *Thematical* part is that, which Treateth of Themes, with their various affections, and second Notions, as of the matter of which Logical Instruments are composed.

4. The *Organical* part, is that which treateth of these Instruments, and their Composition.

5. *A Theme*, is any thing propounded to the

the understanding, that it may be known.

6. *A Theme*, is either *simple* or *compound*.

7. *A Simple Theme*, is one Voice, signifying one thing as, a *Man*, *a Horse*.

8. *A Compound Theme*, is a Theme made of several simple themes rightly Joyned together; signifying many or several things; such are all Orations.

9. *A Simple Theme or Voice*, is,

1. *Concrete*, which expresseth a thing Concretely or Joyntly; as, *Learned*.

2. *Abstract*, which noteth something Abstracted from all others; as, *Learning*.

10. *An Abstract Voice*, or simple theme, is Singular or Universal.

11. *A singular theme*, is that which in its own nature can be spoken of no more than one, and is called an Individual.

12. *Individuals* are of two sorts.

1. Such as are Certain and Determinate; as, *this man*, *Paul*, *Alexander*, *the Apostle of the Gentiles*, &c.

2. Such as are uncertain and indeterminate, as *some man*.

13. *An Universal simple Theme*, otherwise called a Predicable, is that which may be spoken of many; as, *a Body*; and this is either of the first or second Intention.

14. *A simple Theme of the first intention*, is that which expresseth the thing it self; as, *Gold*, *Stone*, &c. so called, because they are the names by which the things themselves are first made known.

15. A

15. A *simple Theme of the second Intention*, is that which doth not expreſs the things it ſelf, but certain affections agreeing to the thing, and ſuch are all Words of *Art*; as, *a Noun, a Metaphor, &c.*

16. An *Univerſal ſimple Theme*, may be ſpoken of many, two ways.

1. In *Quid*? or by declaring what a thing is; and thus it is ſpoken of ſuch as do differ in the *ſpecies*, and is called *Genus*; as, *a living Creature, colour, &c.* or elſe of ſuch as do differ in number only, and is called *ſpecies*; as, *a Man.*

2. In *Quale*, or by declaring what a kind of thing it is, of which it is ſpoken; & that Eſſentially or *Accidentally*, Eſſentially, and then it is called Difference, the which is,

1. *Diviſive*, by which a *Genus* is divided into its ſeveral *ſpecies*, as by rational and irrational a Living Creature is divided into a Man or a Beaſt.

2. *Conſtitution*, which doth Eſſentially conſtitute ſome *ſpecies*, and this is,

1. *Generical*, which doth conſtitute ſome remote *ſpecies*, but not the next, for the next is the *Genus*, thus *ſenſibility* in reſpect of Man, is a *generical difference*, conſtituting firſt a living *Creature*, and then a man. And this is always ſpoken of many differing in *ſpecies*, or *number*.

2. *Specifical*, which doth *conſtitute* the neareſt *ſpecies*; as, rationalibility doth *conſtitute man*.

2. *Accidentally*, and that either of neceſ-

ſity,

ſity, and then it is called a proper Accident, which is convertable with its *Species*, perpetually inherent in every of them, and in no other, as the viſible faculty in a Man.

Or not of neceſſity, and then it is called a common or ſimple Accident, not convertible with its *Species*; as *white*.

17. All *ſimple Themes*, may be reduced to ten ranks or orders, called *Predicaments*, of which ſome are more principal, ſome leſs.

18. The more principal *Predicaments* are the firſt ſix, the leſs principal, are the other four.

19. The *Predicamental Ranks* or *Orders*, are of two ſorts, the one of *Subſtance*, and the other of *Accidents*.

20. Of *Subſtance*, there is only one, and it is called by that name *Subſtance*, which is a thing ſubſiſting of it ſelf, and it is either firſt or ſecond.

21. The firſt *ſubſtance*, is a Singular ſubſtance, or a ſubſtance that cannot be predicated of its ſubject; as, *Alexander*.

22. The ſecond *Subſtance* is an Univerſal ſubſtance, or a ſubſtance which may be predicated of its ſubject; as, *a Man*, *a Horſe*. The firſt ſubſtance is chiefly and properly a ſubſtance, and among the ſecond ſubſtances, every one is by ſo much more a ſubſtance, by how much it is nearer to the firſt.

23. The *Predicamental Ranks* or *Orders* of Accidents, are of two ſorts.

1. *Abſolute*, as the Predicaments of *quantity*,

tity, *Quality*, *Action*, and *Passion*.

2. *Relative*, as the Predicament of *Relation*.

24. *Quantity*, is an absolute accident, by which a thing is said to be great in bulk or number.

25. *Quality*, is an absolute *Accident*, by which it is simply and determinately declared what kind of thing, that subject is, of which it is the *Quality*.

26. *Action*, is an *Accident*, by which a subject is said to be doing.

27. *Passion*, is an *Accident*, by which the subject is called Patient; or it is the reception of *Action*.

28. *Relation*, is a respective accident, by which one thing is predicated of another, or may by some way be referred unto another.

29. The less principal Predicaments are these four, *When*, *Where*, *Scituation*, and *Habit*.

30. The Predicament *When*, is an accident, by which finite things are said to be in time, past, present, or to come.

31. The Predicament *Where*, is an accident, by which things finite, are said to be in some place.

32. The Predicament of *Scituation*, is a certain Ordination, or placing of parts in Generation.

33. The Predicament of *Habit*, is an accident, by which some garment or something like a Garment, is put about, hanged upon, or some way or other joyned to a Body.

CHAP. II.

Of Compounded Themes.

HItherto of *Simple Themes*: *Compounded Themes*, or such as are made of several Simple Themes are next to be considered; otherwise called *Enunciations*, or *Propositions*.

2. An *Enunciation*, or *Proposition*, is an Indicative, Congruent and perfect Oration, signifying true or false without any Ambiguity.

3. The parts of a Proposition are two, the parts Signing or Signed.

4. The parts Signing are *simple terms*, whose parts can signifie nothing, being separated from the whole, or no such thing as they did signifie being joyned all together.

5. These *simple terms* are of two sorts, *Categorematical*, or *Syncategorematical*.

6. *Categorematical*, or Significative terms, or such simple terms, as do by themselves signifie something perfectly; and these are either *Nouns* or *Verbs*.

7. A *Noun*, is a simple term or word, which doth signifie some certain thing without destinction of time; as, *a man, a horse*.

8. A *Verb*, is a simple term, which doth signifie something, with some *destinction* of *time past*, present, or to come; as, *he runneth*.

9. *Syncategorematical*, or Consignificative terms, are simple terms, which of themselves do not signifie any certain thing, or con-

constitute a Proposition, but being joyned with other Words, are significative, to express the manner of such a thing; and such are all Words which serve to express the quantity of a proposition; as, *all, none, some, &c.* with all Adverbs, Conjunctions, Prepositions, and Interjections.

10. The parts signed are three; the *subject*, the *predicate*, and the *Copula*.

11. The *subject* is all that which precedes the *Copula* in the Proposition.

12. The *Predicate*, is all that which is spoken of the *subject*.

13. The *Copula*, is the principal Verb, joyning the *Predicate* to *the subject*, and in every Proposition is some person of this Verb Substantive, as in this Proposition, *A Man is a living Creature*; *a Man* is the *subject*; *a living Creature* is the *Predicate*; and the Verb is the *Copula*; sometimes the *Copula* is some Person of a Verb Adjective; as in this Proposition, *Socrates lived at Athens.*

Here note, that the subject doth not always precede, and the *predicate* follow the *Copula*, in order of the parts or terms, but in sense and construction; and also, that in some Propositions the three terms are not always expresst, but implyed; as, *I walk, for I am walking.*

14. *Propositions* are distinguish'd *three* ways, according to *Substance*, *Quantity*, and *Quality*.

15. A *Proposition*, in respect of the substance or parts of which it doth consist, is either *Categorical* or *Hypothetical*. 16. A

16. A *Categorical Proposition*, is that which doth consist of one *subject*, one *Predicate*, and one *Copula*; as, *a man is a Living Creature*, and this is either *Pure* or *Modal*.

17. *A Pure Categorical Proposition*, is when the *Predicate* is purely affirmed or denyed of the *subject*, without expressing the manner of affirming or denying.

18. A *Modal Categorical Proposition*, is when besides the *subject*, *predicate*, and *Copula*, we add some modification, to shew how the *Predicate* is in the *Subject*, as, *it is necessary*; *it is contingent*, *it is possible*; *it is impossible that a man should be without reason*.

19. An *Hypothetical Proposition*, is that which doth consist of two *Categorical Propositions*, joyned together by some Conjunction, as, *if a man be a living Creature, then a man is a Body*.

20. A *Proposition*, in respect of *Quality*, is *distinguished* two ways; first, according to the *Quality* of the sign, and so it is Affirmative or Negative; secondly, according to the *quantity* of the thing; & so it is either True or False.

21. A *Proposition*, in respect of *Quantity*, is *universal*, *particular*, *indefinite*, or *singular*.

22. An *Universal proposition*, is that which hath a note of Universality added to a common or universal Subject; as, *every man is a Living Creature*.

23. A *particular proposition*, is that in which a note of *particularity* is added to an *universal* Subject;

Subject; as, *some man is a Living Creature.*

24. An *Indefinite proposition*, is that, in which no note, whether Universal or Particular is put before the universal Subject; as, *a man is a Living Creature.*

25. A *Singular proposition*, is that in which the subject is singular, whether it be a *proper* Name; as, *Socrates is a Philosopher*; or whether it be a common name, with a note of *singularity* set before it; as, *this man is Learned.*

26. *Pure Categorical propositions*, as they have reference to one another, have three affections; *Opposition*, *Æquipollency*, and *Conversion.*

27. *Opposition*, is the repugnancy of two *categorical propositions*, either in *quantity* alone, or in *quality* alone, or else in *quantity* and *quality* both, in which there is the same *subject*, the same *predicate*, and the same *Copula*, as, *every man is just*, *no man is just.*

28. The *categorical propositions*, may be said to be opposite four ways; *Contrarily*, *Subcontrarily*, *Subalternately*, and *Contradictorily.*

29. Two *propositions*, that are *contrarily*, and *subcontrarily* opposite, are opposite only in *quality*; and such as are *subalternately* opposite, are opposite only in *quantity*; and such as are *contradictorily* opposite, are opposite both in *quantity* and *quality.*

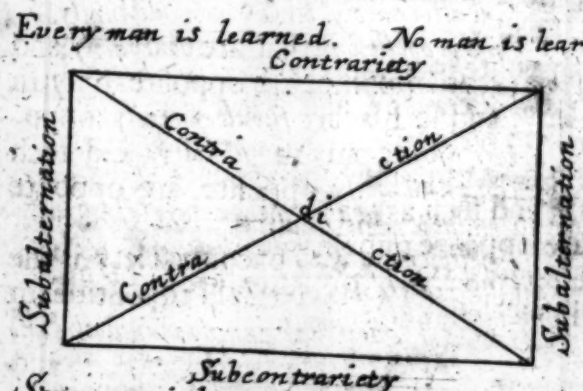
30. *Opposition*, by way of contrariety, is the repugnancy of two Universal Propositions in *quality*; as, *every man doth run*, *no man doth run*;

and these in a contingent matter, may be both False, but cannot be both together true.

31. *Subcontrary Opposition*, is the repugnancy of two particular Propositions in *quality*; as, *some man doth run, some man doth not run*; and these in a contingent matter may be both true, but cannot be both together False.

32. *Subalternate Opposition*, is the repugnancy of two Affirmative, or two Negative Propositions in their *quantity*; as, *every man doth run, some man doth run.*

33. *Contradictory Opposition*, is the repugnancy of two Propositions, both in quality and in *quantity*, so that if one of them be Affirmative, the other shall be Negative; if one be Universal, the other shall be particular; as, *Every man is Learned, some man is not learned*: All which may be easily apprehended by the following Scheme.



34. *Æquipollency*, is the equivalency of two Propoſitions, in *ſenſe* and *ſignification*, though they differ in Words, by virtue of this Word of Negation (*not*) being ſet before the Sign and Subject, after the Sign and Subject, or both before and after, in which there is the ſame *Subject*, and the ſame Predicate; as, *ſome man is Learned*; *not every man is Learned*: The ſeveral varieties whereof are fully expreſſed in theſe Diſtichs.

If after ſign and ſubject, this (not) *be,*
Contraries then, make Æquipollencie.
Only before make contradictories,
But 'fore and aft' are ſubalternate guiſe.

35. *Converſion*, is an apt mutation of the whole *ſubject*, into the place of the whole *Predicate*, and of the whole *Predicate*, into the place of the whole *ſubject*, keeping the ſame Quality, but ſometimes changing the Quantity; as, *Every man is a Living Creature*; *ſome Living Creature is a man.*

36. This *Converſion* is three-fold;

1. *Simple*, in which the predicate is changed into the place of the whole Subject, and the Contrary, keeping the ſame both quality and quantity; as, *No man is a Stone, therefore no ſtone is a man.*

2. By *Accident*, in which the whole predicate is changed into the place of the whole Subject, and the Contrary, keeping the ſame

Quality, but changing of the Quantity; as, *Every man is a living Creature, therefore ſome Living Creature is a man.*

3. By *Contrapoſition*, in which the whole Subject is changed into the place of the whole predicate; and the contrary, keeping both the ſame Quality and Quantity, but changing the terms from Finite to Infinite; as, *Every-Man is a Living Creature, therefore every thing that is a Living Creature, is not a man:* What Propoſitions may be converted this or that way, theſe Verſes do expreſs.

E E, I I, Converſion Simple make.
A I, E O, of Accident partake.
A A, O O, for Contrapoſits ſake.

And what theſe Letters *A, E, I, O,* do ſignifie theſe Diſtichs do declare:

A, affirmes, E, denies both univerſal are,
I, affirms, O, denies, but both particular.

CHAP.

CHAP. III.

Of Diſinition and Diviſion.

HAving done with the firſt part of *Logick*, namely, that which treateth of Themes. I come now unto the ſecond, called the *Organical*, or that which treateth of *Logical* Inſtruments, and their Compoſition.

2. *Logical* Inſtruments are four; *Definition*, *Diviſion*, *Argumentation*, and *Method*.

3. *Definition*, is the explication of the thing which is defined; and this is either *Nominal*, or *Real*.

4. A *Nominal Diſinition*, is that which ſheweth the Signification of the Name; whether it be by giving the Etymology thereof, or by expreſſing it by ſome other Synonymous word more generally known.

5. A *Real Definition*, is that which ſheweth what the thing is; and this is either perfect or imperfect.

6. A *Real* and a *Perfect Diſinition*, is that which doth explain the thing by Eſſential Attributes.

7. A *Real*, but *Imperfect Definition*, otherwiſe called a *Deſcription*, is that which explains the Nature of a thing, by certain Accidental Attributes.

8. Diviſion, is the Deduction of ſome thing

thing that is large, into a straighter and narrower comprehension; and this is either of some ambiguous word, into its several significations, and then it is called *Distinction*, or of the whole into its parts.

9. The whole is either *Simple*, or *Aggregate*; *Division* of the whole, simply and properly so called is three-fold.

1. *Universal* into its subjective parts, or of the General into the Specials; as, to divide Animal into Man and Beast.

2. *Essential*, which resolves the whole into essential parts, and this either of a *Species* into its *Genus* and *Difference*, or of some special nature into its matter and form; as, *A Man into Soul and Body.*

3. *Integral*, which resolveth the whole into Integral parts, and this is the Division of some individual, either into its sensible or material parts.

4. *Division* of the aggregated whole into its parts, and by Accident is five-fold.

1. When the Subject may be divided by its Accidents; as, *Men are Learned or Unlearned.*

2. When an Accident may be divided by its Subjects; as, *Feavers are in the Spirits or in the Humours, or in the solid parts.*

3. When an Accident may be divided by Accidents; as, *Good is either profitable, honest, or pleasant.*

4. When things may be divided by their Objects;

Objects; as, *Sight by Colours, Hearing by Sound.*

5. When Causes may be divided by their Effects; and the Contrary; as, *Heavenly heat is from the Sun, and Elementary from Fire.*

CHAP. IV.

Of Argumentation.

ARgumentation is an Oration by which some Problem is proved by inference.

1. A *Problem*, is the proposition or Question to be proved; the which Problem, when it is so proved is the Conclusion, and follows the Illative note, or note of inference: All that which precedes is the Antecedent, that which follows is the Consequent or Conclusion; the Illative is commonly this word (*therefore*,) and in this doth the tye or force of the Argument consist.

2. *Argumentation*, may be considered either in reference to the form and manner of Arguing, which is the more general consideration; or as it is restrained to certain matter, as shall be shewed in his place.

3. The kinds of *Argumentation* are usually reckoned to be four; *Syllogism*, *Induction*, *En-*

Enthymeme, and Example, but may be reduced to two; for an *Enthymeme* is nothing but an imperfect *Syllogism*; an *Example*, an imperfect *Induction*; Other less principal kinds of Argumentation there are, which either are of no use, or may be reduced to a *Syllogism*; as, *Sorites* and *Dilemma*, which are indeed redundant *Syllogisms*; *Sorites* Categorical, and *Dilemma* Hypothetical.

4. A *Syllogism*, is an Oration, in which something being taken for granted, something else not granted before, is proved or inferred from them.

5. A *Syllogism* is two-fold, *Categorical*, in which all the propositions are *Categorical*: or *Hypothetical*, in which one or more of the propositions are *Hypothetical*; in both which we are to consider the Matter and the Form.

6. The *Matter* of a Syllogism, is either *Remote* or *Next*.

7. The *Remote matter*, is that of which it is remotely made, as the Simple Terms which in the propositions of the Syllogism are made Subject and predicate.

8. The *Simple Terms* of a Syllogism are three, of which one is called the Middle Term, the other two are the *Major* and the *Minor* Extreams, The *Major* and *Minor Extreams* are the *Predicate*, and the other the *Subject* of the question, and the Middle Term or Argument, is the Term not expressed

preſſed in the queſtion, but is united once to the *Major Extream*, and once to the *Minor*.

9. The next or immediate matter of a Syllogiſm, is that of which the Syllogiſm is immediately made, as the three propoſitions, which are made of the ſimple terms, of which the firſt is called the *Major*, the ſecond the *Minor*, & the third is call'd the *Concluſion*.

10. The form of a Syllogiſm is the right diſpoſing of the two-fold Matter, Next and Remote, and this comprehendeth two things, *Figure*, and *Mood*; the one, to wit *Figure*, hath reſpect to the Remote Matter or Simple Terms, and Moods reſpects the next Matter or the propoſitions.

11. A *Figure*, is the fit diſpoſing of the middle Terms with the Extreams, in reference to ſubjection and Predication; this is three-fold.

12. The firſt Figure maketh that which is the *middle ſimple term* to be the *ſubject* in the *major* propoſition and the *Predicate* in the *minor*.

13. The ſecond *Figure*, maketh the *middle ſimple term* to be the *Predicate*, both in the *major* and the *minor* propoſitions.

14. The third Figure maketh the *middle ſimple term* to be the ſubject both in the *major* and the *minor* propoſitions; according to theſe Diſtichs.

Both ſub *and* præ, *doth the firſt Figure uſe.*
Twice præ *the next, the third t vice* ſub *I muſe.*

15. A *Mood* is the diſpoſing of the propoſitions according to quantity and quality.

16. There are 19 Moods, of which there are nine in the firſt Figure; four in the ſecond; and ſix in the third, according to theſe Verſes.

1. *Barbara, Celarent, Darii, Ferio, Baralipton.*
Celantes, Dabitis, Fapeſmo, Friceſomorum.
2. *Ceſare, Cameſtres, Feſtino, Baroco.*
3. *Darapti:*
Felapton, Diſamis, Datiſi, Bocardo, Feriſon.

17. Theſe moods are ſo many words of Art, which ſerve only to denote the quality and quantity of every propoſition, by help of the Vowels, *A, E, I, O*, as hath been ſhewed already; and are ſome of them perfect, as the four firſt Moods in the firſt Figure, and all the moods in the ſecond and third Figures; the reſt are imperfect.

18. And the queſtion propounded is proved by or inferred from the premiſes, by help of theſe moods two ways, *viz. Directly*, and *Indirectly*.

1. *Directly*, when the *Minor* Extream is the *ſubject* in the *Concluſion*, and the *Major* in the *Predicate*.

2. *Indirectly*, when the *Major* Extream is the *ſubject* in the *Concluſion*, and the *Minor* the *Predicate*, and this is in the five laſt moods of the firſt Figure only, according to theſe Diſtichs.

All

All the Nineteen directly do conclude,
Except of Figure firſt, the laſt 5 Mood.

19. Theſe things premiſed, a Syllogiſm, may be made in any Mood and Figure in this manner.

The queſtion propounded is always the concluſion of the Syllogiſm, and by the quantity thereof doth plainly ſhew in what mood or moods it may be framed, and by conſequence, in what Figure alſo.

20. If the Syllogiſm be to be made in ſuch a mood as doth directly infer the *Concluſion* from the *Premiſes*; then the *ſubject* in the *Propoſition* is the *Minor* Extream, and the *Predicate* the *Major*; as in the four firſt moods of the firſt Figure, and in all the Moods of the ſecond and third Figures; but in the five laſt Moods of the firſt Figure, the *ſubject* in the *Propoſition* is the *Major* Extream and the *Predicate* the *Minor*; and the middle term is the Cauſe or Argument by which the truth or falſitie of the *propoſition* is to be proved.

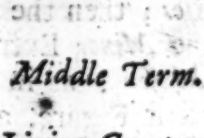
21. The Middle Term or Argument being joyned to the *Major Extream*, doth make the *Major propoſition*, and being joyned to the *Minor Extream*, it maketh the *minor propoſition*.

Example.

Let this be the Propoſition, *No Man is a ſtone*: This Propoſition being an Univerſal Negative, the Syllogiſm may be framed in *Celarent*, *Celantes*, *Ceſare* or *Cameſtres*; if in *Celarent*, *man* is the *Minor Extream*, and *Stone* the *Major*; and to find out the middle Term, I conſider of ſome Reaſon or Argument by which to prove the Queſtion; as, *A Man is not a Stone, becauſe he is a Living Creature*; ſo then *Living Creature* is the Middle Term, and theſe three Terms being thus placed;

Middle Term.

Living Creature.



Minor Extream. *Major Extream.*

Man. *Stone.*

Becauſe *Celarent* belongs to the firſt Figure, the middle Term *Living Creature* muſt be the *Subject* in the *Major Propoſition*, and the *Predicate* in the *Minor*; thus,

	Subj.	*Pred.*
Major.	*Living Creature.*	———
Minor.	———	*Living Creature.*
Conclu.	*No man is a Stone.*	

And

And joyning this middle Term to the *Major Extream*, and alſo to the *Minor*; the ſeveral Propoſitions will be theſe;

Major. *A living Creature is not a ſtone.*
Minor. *A man is a living Creature.*
Conclu. *A man is not a ſtone.*

Laſtly adding the Quantity to every Propoſition according to the Vowels in this Mood, the Compleat Syllogiſm is,

Major. } *Ce-* *No living Creature is a ſtone.*
Minor. } *la-* *Every man is a living Creature.*
Conclu. } *rent.* *No man is a ſtone.*

The like may be done in the other moods.

22. An *Enthymem*, is an Imperfect Syllogiſm, inferring the Concluſion from ſome one Propoſition only; as, *A man is a living Creature, therefore he hath a ſoul.*

23. An *Induction*, is an Imperfect ſyllogiſm, in which from many ſingulars, ſome Univerſal Concluſion is inferred; as, *This man is a living Creature, and that man is a living Creature*, &c. *therefore every man is a living Creature.*

24. *Example*, is an imperfect ſyllogiſm, in which from one or more ſingulars, we infer another particular; as, *Catiline was puniſhed*

for making of Sedition, therefore this Seditious Fellow ſhould be puniſhed.

25. *Sorites*, is an imperfect ſyllogiſm, in which, from four or more Premiſes, we infer a Concluſion, in which the firſt ſubject is joyned with the laſt Predicate; as, *Socrates is a man, a man is a living Creature, a living Creature is a Body, a Body is a ſubſtance*, therefore *Socrates is a ſubſtance.*

26. A *Dilemma*, is an Argumentation which by disjoyning of the Members, doth ſo enforce the Adverſary, that which part ſoever he chooſeth, he will be catched, as, *Tribute muſt be given to* Cæſar, *or to God; If to God, then not to* Cæſar, *and this is Treaſon; If to* Cæſar, *then not to God, and this is Sacriledge.*

And thus much concerning a ſyllogiſm in the General, with the ſeveral kinds and forms thereof.

CHAP. V.

Of A Material Syllogiſm.

I Come now to ſpeak of a *Special* or *Material ſyllogiſm*, as it is conſtrained to certain Conditions of Matter.

2. A *ſpecial* or *material ſyllogiſm*, is of three

three sorts; *Apodictical*, *Dialectical* and *Sophistical*.

3. An *Apodictical syllogism*, otherwise called a *Demonstration*, may be defined two ways, either from the end, or from the matter of *Demonstration*.

4. From the end of *Demonstration*, an *Apodictical syllogism*, is a *syllogism* begetting knowledge, or making to know. And we are then said to know a thing, when we know the cause for which it is so, and cannot be otherwise.

5. All Knowledge is of such Conclusions, to which we assent, for our preceding knowledge of the Premises; and the *Præcognita* in every Science are these three: The *Subject*, the *Affection*, and the *Cause*. And the means by which these are foreknown, are called *Præcognitions*, and they are two; *That a thing is*, and *what a thing is*.

6. The *subject*, is the less Extream, in a *Demonstration*, concerning which some accident is Demonstrated by its next *Cause*; as, *a man, concerning whom we must know both that he is*, and *what he is*.

7. *Affection* or *Passion*, is a proper accident, which is Demonstrated of the *subject*, by a proper *Cause*, it is always the greater Extream, which is Predicated in the Conclusion; as, *Risibility*, the which is necessary to be foreknown, in respect of its name, *What it is*, but not, *that it is*; for that is the thing

to be enquired after, the thing we are to find by Denomination.

8. A *Cauſe*, is that by which the *Affection* is Demonſtrated of its *ſubject*, and is always the *Major Propoſition* in the Demonſtration; as, *Every rational Animal is riſible*; what the *Cauſe* is cannot be foreknown, becauſe it is a compounded Propoſition, but it ought to be known, That it is, or elſe the Concluſion cannot be inferr'd from it.

9. An *Apodictical ſyllogiſm*, being defined from the matter of Demonſtration, is a *ſyllogiſm*, which proveth its Concluſion from ſuch Premiſes, as are of themſelves ſufficiently known.

10. A *Demonſtration*, is to be conſidered, either in reſpect of the Matter or in reſpect of the Form.

11. In reſpect of the Matter, one kind of *Demonſtration*, ſheweth why the *Predicate* is inherent in the *ſubject*, and another ſheweth that it is inherent in the *ſubject*.

12. In the firſt of theſe kinds of Demonſtration, called the *Demonſtration cauſal*, why a thing is; the Conditions to be obſerved, do partly belong to the Queſtion, partly to the *Cauſe* or *Medium* of the *Demonſtration*, and partly to the *Premiſes*.

13. Every Queſtion doth not admit of the firſt and moſt perfect kind of Demonſtration, called, *Why a thing is?* but ſuch a Queſtion only as is true, and hath a certain

and

and immutable Cause of its own Truth.

14. The *Medium* of a Demonstration, ought to be the next Cause of the *Predicate*; and that either *Efficient* or *Final*, and the *Efficient* either *Internal* or *External*.

15. The Conditions to be observed in the Premises of a Demonstration, are *Absolute* or *Relative*.

16. The *Absolute Conditions* are two; the first is, that the Propositions be necessarily true and reciprocal; The second, is that they be immediate or first, in respect of the subject; as, *A man is Rational*, and in respect of the Causes; as, *That which is rational, is visible, a man is rational*, Ergo.

17. The *Relative Conditions* to be observed in reference to the Conclusion, are three. 1. That the *Premises* be the Cause of the *Conclusion*. 2. That they be before it; and 3. That they be more known than the *Conclusion*.

18. The other less principal kind of Demonstration, in respect of the Matter, or the Demonstration *what*, is two-fold, the one is from some sensible Effect, and the other from a remote Cause.

19. The form of these Demonstrations, is descerned partly from the *Quantity*, and so it is *Universal* or *Particular*; Partly from the *Quality*, and so it is *Affirmative* or *Negative*; partly from the manner of the proof, and so it is *Ostensive*, or by *Reduction* to Impossibility.

CHAP. VI.

Of a Topical Syllogism.

HItherto we have ſpoken of a Demonſtrative ſyllogiſm, whoſe matter is neceſſary, and the end a perfect Knowledge; come we now to a *Dialectical* or *Topical ſyllogiſm*, whoſe matter is Probable and Contingent, and the end Opinion.

2. In a *Dialectical*, or *Topical ſyllogiſm*, we are to conſider of *Problems*, *Propoſitions*, and *Invention of Arguments*.

3. A *Problem* or *Queſtion*, is the thing of which it is probably diſcourſed, and the Concluſion of a ſyllogiſm already made.

4. *Dialectical Propoſitions*, ought to be certain, at leaſt probable, and not Paradoxes; now that is ſaid to be Probable, which not being abſolutely true, doth ſeem to be true rather than falſe: And that is ſaid to be a Paradox, which is true, though contrary to the vulgar opinion.

5. For the Invention of Arguments, we are to conſider Common places and Rules.

6. A *Place*, is common Note, by whoſe help an Argument is found.

7. A *Rule* or *Canon*, is a Propoſition, containing

taining the Reason of the Consequence, in a *Dialectical syllogism*.

8. *Arguments* are of two sorts, *Artificial* and *Inartificial*.

9. *Artificial Arguments*, are such as from the consideration of the parts of a Problem, are not found but by Rules of Art.

10. *Inartificial Arguments*, are such as are found without any help of Art, and these are nothing but Testimonies.

11. *Artificial Arguments*, may be raised from these seven *Topicks* or *Heads*. 1. From the *Cause* and the *Effect*. 2. From the *subject* and the *Accident*. 3. From *Dissimilary* and *Comparison*. 4. From *Conjugates* and *Notation*. 5. From the Whole and its Parts. 6. From *Genus* and *Species*. 7. From *Definition and Division*.

12. A *Cause* in General, may be defined to be that, by whose power a thing is.

An *Argument* therefore from the *Cause*, is when in a probable syllogism, the middle term is the cause of the *Major* Extream.

13. There are two kinds of *Causes*; *Internal* as the *material*, or matter, of which a thing is made; and the *Formal*, by which a thing is; as, *The shape and form of a statue.*

External, as the Efficient, which doth bring the thing to pass; and the *Final* or *End*, for which a thing is done.

14. An *Argument* from the Efficient Cause, is when in a probable syllogism, the

middle

middle Term is the Efficient of the *Major* Extream: as, *The Earth is Diametrically interposed between the Sun and the Moon, therefore the Moon shall be eclipsed.*

15. An *Argument* from the *Final Cause*, is when in a probable syllogism, the *middle Term* is the *Final Cause* of the *major* Extream.

16. An *Argument* from the *material cause*, is when in a probable syllogism, the *middle Term* is the *material cause* of the *Major* Extream, or the *Genus* or *Species* thereof.

17. An *Argument* from the *Formal Cause*, is when in a Probable syllogism, the *middle Term* is the *Form*, *Definition*, *Description*, or *Difference* of the *major* Extream.

18. In the *Topicks* of the *subject* and the *Accident*, we do not take the *subject* for the *substance*, in which the *Accident* is inherent, or the *Accident* for that which doth precisely and adiquately adhere to the *substance*; but *subject* is here taken for all that, to which any thing not belonging to its essence is attributed: And *Accident* is here taken for any such attribute, as, Number is the *subject* of Equality, that is, it is an *Accident* of an *Accident*.

19. An *Argument* from the *subject*, is as oft as the *middle Term* in a Probable syllogism, is the *subject* of the *major* Extream.

21. The third *General Topick* for the Invention of Arguments, is from *Dessentainies* and *Comparison*. 22. *Dis-*

22. *Dessentanes*, are either *Opposites* or *Disparates*; as, *a Horse*, and *a Bull*: There are four kinds of *Opposites*; *Relative*, *Contrary*, *Privative*, and *Contradictory*. *Comparisons* are either in respect of quality; as, *like and unlike*, or in respect of quantity, or also of degrees; as, *equal and unequal*; and what ever may be said to be *more* or *less* or *equal*.

23. An *Argument* from *Dissentanies*, is when in a Probable Syllogism, the *middle Term* is opposed to the *Major* Extream, whether it be by way of a *Disparate*, or a *Contrary*, or otherwise.

24. An *Argument* from *Comparison*, is as oft as in a probable syllogism, one part of the *Major* proposition is compared with the other, in reference to their agreement or their disagreement.

25. The fourth general *Topick*, for the invention of Arguments, is from *Conjugates* and *Notation*. And they are properly called *Conjugates*, which for the affinity of signification, have also an affinity in the Voice or Sound; as, *Just*, *Justice*, and *Justly*; some *Conjugates* are only Nominal, and some Real, and some both, and do comprehend *Denominatives* under them, and are either *substantives* where one is a *Noun substantive* abstracted from the *Subject*; as, *Justice*, *Just*; or *Adjectives*, where they be both *Denominatives*, or *Concretes*, which

shew the form in the Abstract; as, *Just*, *Justly*. *Notation* or *Etymology*, is the Explication of a Word by the Original thereof; as, *a Consul*, from *Counselling the Common-Wealth*.

26. An Argument from *Conjugates*, is as oft as in a probable syllogism; the one the *Conjugates* in the *major* proposition, is the *subject* of the *major* Term; as, *He that doth Justly is Just*.

27. The first General *Topick* for the Inventing of Arguments, is from the whole and its parts. And an Argument from the thing divided to the divided members, is as oft as the thing divided is the *middle Term*, and the dividing Members the *Major* Extream, in a Probable Syllogism. And an Argument from the dividing Members, to the thing divided, is as oft as the dividing Members are the *middle Term*, and the thing divided the *Major* Extream.

28. The sixth General *Topick*, is from *Genus* and *Species*; And an Argument from *Genus* and *Species*, is when we prove that a thing doth not agree with the *Genus*, because it doth not agree with the *species*; or that it doth not agree with the *species*, because it doth not agree with the *genus*.

29. The seventh General *Topick* for the Inventing of Arguments, is from *Definition* and *Division*. We raise an Argument from the *Topick* or *Definition*, when we seek for the

the *Definition* of either Extream, that is, of the *Subject* or the *Predicate* in the question, which being found, is put into the place of the *Mean*, that it may be known whether the Extreams should be conjoyned or separated; thus we prove that *Peter is a man*, because he is a *Rational living Creature*. We argue from the *Topick* of *Division*, when we shew something to agree with the dividing Members, because it agrees with the thing divided, or not to agree with the thing divided, because it doth not agree with any of the Dividing Members.

30. *Inartificial Arguments*, are only such as are raised from Divine or Humane Testimony. And an Argument is raised from Testimony, as oft as the Authority of him that beareth witness, is the *middle Term*, agreeing or not agreeing with the *Major* Extream.

CHAP. VII.

Of a Sophistical Syllogism.

A *Sophistical Syllogysm*, is a Captious Argumentation, which is seemingly, or apparently true, but is indeed deceitful.

2. *Sophistical*, or Fallacious Arguing, is either in respect of the Words or of the Things.

3. *Fallacies in Words*, are five; *Ambiguitie*, *Amphibolie*, *Composition*, *Division*, and *Figure of a Word*.

4. *Fallacies in things* are seven, *Accident*, Of a thing spoken after a sort, to a thing spoken Simply; Ignorance of the Argument; a false or wrong Cause, Consequent, Beginning of the Question, and an asking of many Questions.

CHAP. VIII.

Of Method.

1. *Method* is the disposing of things belonging to the same Matter or Subject, so, as that they may be best understood, and easiest remembred.

2. *Method* is two-fold, *Natural* or *Arbitrary*.

3. A *Natural Method* is that, in which the order of Nature and our distinct Knowledge is observed.

4. In a *Natural Method*, we must speak first of Generals, and then of Particulars; and as we proceed from one thing to another, every part must have a dependence on that, which was last spoken of by some apt transition.

5. A *Natural Method* is either *Total*, or *Partial*.

6. A *Total Method* is that, in which a whole Science is Methodically ordered or dispersed. And this is either, *Synthetical*, or *Analytical*.

7. A *Synthetical* or *Compositive Method* is that, which begins with the first and most simple Principles, and so proceeds to those, which do arise from, or are Composed of the first Principles.

8. An *Analytical* or *Resolutive Method*, is

that, which begins with the end, and ſo proceeds ſtill lower and lower, till we come to the firſt and moſt Simple beginnings.

9. A *Partial Method* is that, by which any part of any Art or Science is Methodically ordered or diſpoſed: or by which any particular Theme or Subject is handled by it ſelf.

10. An *Arbitrary Method* is that, which not regarding the Natural order, is fitted for ſuch a confuſed Knowledge, as may be moſt taking with the People, or ſute beſt with their Capacities.

And thus much concerning *Method*, which is the fourth and laſt *Logical* Inſtrument; and with this I ſhall conclude theſe my *Logical Precepts*, and laſt Part of my *Engliſh Academy*: He that deſires to be more fully acquainted with theſe Arts and Sciences, may for all, but *Muſick*, Read my other particular Tracts of theſe Subjects, till ſome body that hath more knowledge in them, ſhall furniſh us with more ample and perfect Inſtructions; and as for *Muſick*, I am much of Opinion, that Mr. *Playford*'s *Introduction* may very well ſerve, to Inſtruct our Youth in the firſt Principles of that excellent Science; For which, and all other helps of Learning, *To the only Wiſe God, be all Honour and Glory, now and for ever.* Amen.

FINIS.

The Art and Mistery of NAVIGATION;

As to Observation in taking Heights, &c. *Sailing the Sundry ways,* &c. *And other useful matters worthy of note to Navigators,* &c.

AMongst the many Undertakings, that redound to the Advantage of Mankind, *Navigation* is very considerable; for on it depends not only the Welfare of private Persons, but of Nations and Kingdoms, as being Enriched and Improved in Knowledge by it: Wherefore it is highly necessary to speak something of it in this Treatise of *Arts* and *Sciences*, that may Instruct the Unexperienced, and, perhaps, improve the knowledge of the Elder Practitioners.

In the Treatise of *Astronomy*, you find the names of the Stars, and many other things necessary to be taken notice of in *Navigation*; for on that *Art* much of this depends, especially in taking the Suns height or *Meridian Altitude*, and the Elevation or height

of the Pole, as being the Computation or Distance in *Latitude* from the Æquator, either North or South, or any other Imagined Parralel, as we find East and West is the distance of *Longitude*, where ever the *Meridian* is found, there must consequently be computed an equal distance on either side of it; so that the *Meridian* thus considered, the *Rumb* must be so likewise, for that leading from place to place, may be termed the distance run upon such a point of the Compass. And to come nearer the taking of these distances and heights are the principal things to be observed in this Art as to the Carrying a Ship to any Country and Port, and knowing at any time where you are, and all these (according to the greatest Proficients) are more closely, or briefly comprized. 1. In the difference of the Latitude. 2. In the difference of the Longitude. 3. The *Rumbs*. 4. The distance run upon the *Rumb*.

Now if two of these be known or given, the two that remain may be easily found, the first by *Observation*, and the last by *Trigonometry*, or *Arithmetical Calculation*, &c. And in further consideration of these things, to find the Latitude or *Elevation* of the *Pole*, you must observe the *Meridian Altitude* either of the Sun or Stars, and though there are many ways described to do this, yet what ensues is found the most plain and easy.

Do it by the *Astrolabe* or *Quadrant* in this manner

manner, *viz.* by what we call backward observation, and not troubling your Eyes with looking through the ſights, permit the Sun to ſhine through the ſight, that is next to the *Center*, ſo ordering it, that the beam may fall directly upon the hole of the other ſight, by which means the thread will fall upon the right *Altitude* in the Quadrant, or the *Index* in the *Aſtrolabe* will in the ſame manner divide the degrees of *Altitude*.

If the Sun ſhine not, and you are deſirous to find its *Meridian Altitude*, you may do it by informing your ſelf of the declination and Latitude; And upon this obſervation, if you find the declination *North*, then add to the Complement of the Latitude, which you will ever find to be the ſame with the height of the Æquinoctial, but on the contrary, if it be a *South* declination, then ſubtract from the Complement of the Latitude, and that will at any time give you the *Meridian Altitude*. As put the caſe we find in any place the *Elevation* of the *Pole*, that is the Latitude to be 52 degrees, the complement thereof to 90 degrees, is 38 degrees, which likewiſe is found to be the height of the Æquinoctial, and then it being granted, that on *May* 2. the Sun being 20 degrees, 24 minutes of *Taurus*, his declination Northward is 11 degrees, 56′ 21 s. which, when you add to 38, brings the Suns *Meridian Altitude* to be 55 degrees, 56 minutes, and

12 seconds, but if this be required to be found when the Sun comes to the Æquinoctial, either on the 13 of *September*, or the 11 of *March*, then the height of the ſtars or ſun, when they are upon the *Meridian*, will ſhew the true Latitnde if ſubtracted from 90 degrees, but at other times you muſt find out their declinations, and if it happen Northerly, ſubtract it from the Altitude, but if Southerly, you muſt add it to the Altitude, by which means you will find the height of the Æquinoctial above the Horizon, and Conſequently ſubtracted from 90 degrees, will give you the true Latitude of the place where you make your Obſervation.

If by the Globe you are deſirous to find the *Elevation* of the *Pole*, take the Suns *Meridian Altitude*, bringing the Suns place in the Ecliptick, or the Stars to the *Brazen Meridian*, and ſo move that *Meridian* with the Globe through the notches it ſtands in, till you find the ſtars, or the ſuns places Elevated as many degrees above the Horizon, as their *Meridian Altitude* is; and whilſt the Globe ſtands in this poſition, you may be confident the *Pole* will be Elevated to a true Latitude of the place.

As ſuppoſe you find the Suns place in the beginning of *Cancer*, which may be the 12 of *June*, and the *Meridian Altitude* of the ſun is 62 degrees from the place where you are to make your obſervation, then bring the

the firſt degree of the ſign *Cancer* to the *Meridian*, and Elevate the ſame 62 degrees above the Horizon, and you will find the *Pole* Elevated 51 degrees and 30 minutes.

The next thing in *Navigation* to be conſidered, is the finding the Longitude, which could it be brought to perfection, ſailing would be far more eaſy than it is, and diſcoverys of yet unknown Countrys, Rich perhaps as either *Indias*; but indeed, though many have attempted it, and gone very far, they have never brought to perfection, however, for the light of the Navigator, we will conſider ſome things herein.

Suppoſe the Moon to be Eclipſed, obſerve how much ſooner it begins at a place of known Longitude, for which ſearch the *Ephemerides*, then at the place where you ſtand, and obſerving your Latitude by the ſtars, as has been directed, the true hour of the night may be found; which done, obſerve the difference of time of the Moons beginning to be Eclipſed, or its middle or endings, at the place where you make your obſervation, which ſpaces convert into degrees and minutes, which added or ſubtracted from the hour of the beginning, middle or end of this Eclips at a place of known Longitude, theſe degrees and minutes in their difference between the hour at one place, and the hour at another, added or ſubtracted from the degrees and minutes of the known Longitude,

you

you will find them give the required Longitude.

If the Moon be not Eclipſed, which Eclips cannot be expected upon every occaſion, then you may obſerve it by the Sun and Moons motion, as thus; ſuppoſe, and it is granted, that the Moon is ſlower in motion than the Sun 48 minutes, in 24 hours, or 360 degrees, then by the help of Mathematical Inſtruments, find the true *Meridian* in any place, ſuppoſe the *Weſt-Indias*, &c. you muſt alſo find the hour of the Moons coming to that *Meridian* by the *Ephemerides*, or other helps; and this being calculated for *London*, you find by thoſe helps, that on ſuch a day the Moon comes to the *Meridian*, at four in the Afternoon, and you being the ſame day in the *Indias* aforeſaid, you find her come to the *Meridian* 10 minutes paſt 4, whereupon conſider by the Rule of Proportion, that the Sun and Moons difference in motion, being 48 minutes in 36 degrees, what will it come to in ten minutes, or if 48 gives 360, conſider what ten gives, and the fourth proportional number will be 75d. and ſo much is the diſtance of that place in *India* from *London*, and the longitude of *London* being ſubtracted from that number 20 degrees, and 55 Remainder again ſubtracted from 360, what remains produces the longitude to be 305. Some other ways are laid down to prove a knowledge of the longitude,

gitude, but the whole matter being in a manner in the dark, these may suffice for an Experiment.

But in plain or circular Sailing, the Compass is very much heeded, but sometimes there may be mistakes by the variation of the Needle, which you may Rectifie by the Globe, in this manner; let the Suns place be brought to the East side of the *Horizon*, and observe the Circle of Winds, and then against the Suns place you have the point of the Compass, whereon it riseth, and so proceed to take notice upon what point it rises or sets, observe then the difference happening by the Globe, and by the Compass, and if there be any, that is the Variation, for which Variation, allowing that the Needle will ever shew the *Rumb*, which is the true point of the Compass, as to the steering the Ship.

If you would know how much way your Ship makes in such and such spaces of time, this you may observe by the Logline, or Minute Glass, and by the first so many knots as she runs in half a minute, so many Miles is she counted to Sail in an hour, or it may be done by hanging up a Bullet in a string, which will count the Minutes by its swinging, for if the string be proportioned to 38½ Inches, it will swing about 60 times in a minute, but if longer not so many, and therefore it is left to your discretion, to propor-

tion it as you make observation by the half minute glass, instead of which, this (for necessity) may serve turn.

If you would find the Suns *Amplitude*, and thereby the variation of the Compass, observe, That as the Proportion of the *Cosine* of the Latitude is to the *Radius*, the same you will find the sine of the declination to that of the *Amplitude*, as, It being granted the Latitude of 31 degrees, 23 minutes, its *Cosine*, or *Complement*, is 38 degrees, 28 minutes, and the declination of the Sun 15 degrees, 10 minutes; the *Amplitude* then will be found 24 degrees, 52 minutes North, by reason the declination is so. As for the *Circumference* of the Compass divided into 360 degrees, observe when the Sun rises and sets, how many degrees it is from the direct point of the *Amplitude*, so much you will find the Needle vary in that place.

As for this kind of *Navigation* it is vulgarly proposed in three manner of ways, or Methods, especially, as relating to private Seamen as plain Sailing, *Mersators* way or Instruction of Sailing, and Sailing by an Arch or great Circle, called Circular Sailing. The plain way of sailing is by a plain Chart, which is the most substantial, and that on which the other are grounded, and to those that sail near the Æquinoctial, they have little or no occasion for any other way,

way, as having their degrees of Latitude and Longitude equal, each degree divided in to 60 minutes, and each minute put for a Mile, yet somewhat exceed the *English* measured miles, as containing about 6000 feet; but if you are to come far from the Æquinoctial, then though you may keep your Latitude in plain sailing, yet you will be at a loss for your Longitude, and therefore to be better informed, consider that as the *Radius* or whole sine of 90 degrees, is to 60 Miles, so you will find the *Cosine* of the latitude, is to the Miles contained in one degree of longitude in that latitude, so that in the latitude of 60 degrees, 30 Miles make a degree, as *sine* 90 degrees to 60 Miles 10000, so *Cosine* 60 degrees to 30 Miles 5000. and by this rule we find, that if your departure from the *Meridian* was 280 Miles, and they being divided by 60, reduced into degrees and minutes of longitude under the Æquinoctial, it yields 4 degrees and 4 minutes, but if these 280 Miles happen to be East or west, or your departure from the *Meridian* should be in the latitude of 60 degrees, where 30 Miles make a degree of longitude, then divide the 280 Miles by 30, and you will find it yields 9 degrees $\frac{1}{3}\frac{0}{0}$, or one third, which is 20 minutes for the difference of longitude in that latitude. To sail by *Mercator's* Chart, is little other than coming to a knowledge of the true latitudes, Meridians,

and Elevations of the Poles, Miles, minutes, &c. as when it ſo fall out that one place is under the Æquinoctial, and the other nearer one of the Poles, then we find, the Meridional minutes, anſwerable to that place, which hath latitude, is to be Accounted for the Meridional difference of latitude, or that latitude inlarged.

Again, ſuppoſe both places are towards one of the Poles, thereupon ſubtract the Meridional minutes that are found anſwering to the leſſer latitude, and the remainer will be found to be the Meridional minutes required.

Again, if we find one place to have *North* latitude, and the other be in *South* latitude, then add the Meridional minutes, appertaining to either place together, and you will find the ſum thereof to be the Meridional minutes required; &c.

Circular ſailing is held to be a very good way of ſailing, as the beſt, ſhewing the neareſt way and diſtances between any two places, yet carrys with it ſome little difficulty, ſo that the Seamen ſeldom keep to their courſe near this Arch, wherefore leaving you to conſider of what has been ſaid, I proceed to other uſeful matters.

CHAP.

Horology, or the Curious Art of Dialing made plain and eaſy in deſcribing, and directing the poſitions of the Sundry ſorts of Dials now in uſe; alſo to know by a Sun-dial the time of the night by the Moons ſhaddow.

Dialing is a very Curious ART, and requires much *Care* and *Induſtry* to come up to it in all Points; for of *Dyals* there are ſundry ſorts, varying in ſomewhat or other, according to their *Places*, *Poſitions*, and the Suns Degrees, ſome are movable, and may be carryed from place to place, others fixed, and are found to be *Regular*, or *Irregular*; the *Regular* are ſuch as are on a Plain, directly towards one of the Eminent parts of the world, as full Weſt, or full Eaſt, but the *Irregular* are thoſe that have no direct pointing to any principal quarters of the world, but rather declines them.

Of thoſe called *Regular*, they have many names to diſtinguiſh them; as, The *Meridian Eaſt*, The *Meridian Weſt*, The *Horizontal Dial*, The *Vertical Northward*, and the *Vertical Southward*, The *Æquinoctial* below, The *Æquinoctial* above, the *Polar* below, and the *Polar* above.

The *Horizontal*, is when it is equally diſtant towards the *Horizon*.

The *Vertical*, is a Perpendicular erected above the *Horizon*, tending directly towards the *Vertical* point, being *Parallel* to the *Primary Vertical Circle*, and is *duplex*, as *North Vertical* looking to the other which is *South Vertical*.

The *East* and *West Meridians* have particularly either of them their several ways, being equally distant from the *Meridian Circle*.

The *Æquinoctials* mentioned are those of which either have their several ways equally distant from the *Æquator*, the one above and the other beneath the *Horizon*.

The *Polars* have likewise their different ways, the one being beneath, and the other above, they are found as *Parallels* to the Worlds *Axis*.

The *Irregular* are either inclining, or declining; the first of these is equally distant from any *Vertical Circle*, and from thence is often called *Vertical*, though declining from the *Primary Vertical*, properly so named, and is of two sorts, there being one declining from the South to either East or West, and the other from the North to either East or West.

That which inclines falls away from the *Vertical Point*, having its inclination toward the *Horizon*, as not being equally distant from it.

As for the hours which these several sorts

of

of Dials, are to parcel out time unto, they are Reckoned as to the days they make divers, according to the distant Latitudes, the Suns ascending or declining, yet all allow 24 hours to the day and night, dividing each hour into 60 minutes, and those into seconds parts, and smaller proportion of time, till it can be discerned only by imagination. The days are held in two distinctions, the one natural, and the other Artificial, the Natural day is accounted 12 hours the Artificial as many as the Sun allows either the longer or the lesser it shines.

But to be an exact *Horologian*, observe these methods, be sure to have the exact Elevation of the Pole, which to find, you are directed in the treatise of *Navigation*, for by that your determination of the *Center* of hours must be had also the stile of the Dial's *Altitude*, and the order of it, and whatever is requisite beside of that nature; you must likewise know the true *Meridian* line, that so the Dials Meridian line may have its place directly under the Meridian of the place where it is posited. And he that undertakes this work, must be furnished with such Mathematical and Astronomical Instruments and Materials, as may give him a due understanding of the proportions of time, as a Rule, Compass, Astronomical Quadrant, divided exactly into 90 degrees, with a description of the hour line & points.

and to bring this Ingenious work to perfection, you must be careful the figures of the hours are set at their proper and proportionable distance to answer the moving of the stiles shaddow, and that your stile be well contrived as to its Form and Altitude, and make your observation to fix it exactly; also be very careful in the Application and Disposition of the Dial when it is finished.

But to come to what is more curious, be sure the hours be described, and to do it there are granted to be two right lines secting each other at right *Angles* cross ways, one of them being the *Meridian* line, or the 12*th* hour line, the other is termed the *Occult* line, by which the first cross ways are cut to the right *Angle*, and this is generally called the line of hours, because in it the horary points are designed, but if we come to its more proper denomination, it may be called the Æquinoctial line, since it represents the Æquinoctial Circle, the chief rule of all hours.

Thus much being explained as to Dialing, in general, we come now to more particulars.

If you are desirous to have a right *Dial*, you must be sure to know its right Center, or the Center of the hour, to do which, be very mindful of the Elevation of the Pole, especially in the *Horizontal* Dial, or any of that sort, for they will not declare the hours

in

in any place, but under a certain Elevation, and therefore if they are removed far, you must be again proportioned to that Elevation Conjecture we then the Pole be Elevated 49 degrees in this Region, which is 41, place here the foot of your Compass in the Instruments Center, extending the other foot from that to the Æquinoctial line described in the instrument, where in that part the 41 degrees is cut by the *Radius*, so numbering from the 12th hour line, and transfer this extension of the Compass upon the Dial, having yet the Compasses foot fixed in the Meridian, and Æquinoctial lines, concourse, and the other fix in the distant part of the Meridian line, determining, that point to be the hours Center, and so from thence, and each point in the Æquinoctial line, you are to draw all the lines, which some term, *the Arches of hours*. And further a line is to be drawn through the Center of the hours, a line Parallel to the Æquinoctial, and this is to be accounted the line of the sixth hour, as well in the Evening as the morning, as likewise of the hours of 4 and 5 in the Evening, are to be drawn out beyond the Center of hours, for the like hours in the morning, and so of the rest, equally compeering; and thus you have an exact description of a *Horizontal Dial*, whose figure you may form as you please, placing the Characters of the hours at the end of the line.

If you design a *Vertical Dial*, it may be done upon a *Regular* wall, the same way as the former, yet there is some difference to be observed, not only in the Scituation, but likewise in the *Vertical*, in case of being certain of the *Center* of the hour, the *Polar Elevation* degrees are to be here taken for the *Altitude* of the *stile*, allowing the degrees complement, though the *Horizontal Dial* is the contrary; however, there being a distinction between a *Vertical* to the *North*, and a *Vertical* to the *South*, the *Vertical* to the *North* is, as we may suppose, a *Meridian* Inverted, having the *Center* of hours downwards falling short, in shewing short, in shewing the hours, for in some Adjacent Countreys, it shews but from 4 to 8 in the morning, and the like in the afternoon, and the *South Vertical* hath the *Center* of hours and its *stile* upwards, shewing from the six in the morning to noon.

A *Meridional Dial* either East or West, for the first, it must have a Line *Parallel* drawn to the *Horizon*, and a slight *Circle* at any opening of the Compass, beginning from the *Horizontal* line towards the right side where the *Eastern Dial* is to be drawn, conceiving in the Instrument such an Arch at the like opening of the Compass, in which Arch cut off the *Elevation* of the *Æquator*, and carry the *Interval* to the *Circle* drawn from the point, and allow the Arch to be cut off.

To

To frame an *Æquinoctial Dial*, two lines must be drawn at right *Angles*, whereof one is to be the *Meridian*, the other that of the hour, 6 morning and evening, and from the usual section of these lines, draw a Circle as you think fit to be divided into 24 proportionable and equal parts, for in this kind of Dyaling, all the Intervals must be equal as to the hours.

The *Polar* Dial goes *Parallel* to the *Axis* of the world, lying as it were in it, and is to be Elevated above the *Horizontal Plain*, the same degrees as the worlds pole, the lowermost part in many places, containing not above 4 hours, yet generally the morning hours are 4 and 5, towards the left side the Evening hours 7 and 8, but the topmost shews the hours from 7 in the morning to 5 in the Evening, but not the sixth by reason the Sun then is parallel to the Dial glancing then upon its side.

A Dial of *Irregular Declination* may be best managed by the *Marriners* Compass, and applying the *Semi-Circle* divided in the *Plan* to a competent number of degrees, the pin or stile placed at its Center, so that in that *Meridional* hour, you will perceive the degree the shaddow cuts, and the way it casts, by the which you may the better determine the species, and how it declines; by which observation, you may draw a Dial in any place, fixing your stile of what

what *Magnitude* you please at right Angles.

If you are desirous to find by the shining of the Moon, the hour of the night upon a Dial, suppose you have a *Horizontal* Sun-Dial, movable or fixed, joyn to it a Dial, by some called a Moon Dial, made up of two *Concentrick Circles*, where in one you will meet with the day of the Moons Age, by applying a *Globule* to the number 30, in the other, the 12 hours diversly set down; then knowing the Moons Age, so place your Sun-dial, that the Moon may fairly shine on it, and being placed as for the day, see what hour the Moon shaddows on, as suppose the 8, then place the *Globule*, the hour you find set down in the *Horary Circle*, and then again having recourse to the Moons Age, it will give you the hour required, as suppose it be the 12 of the Moons Age, you will find the shaddow about 5 and a half, which is the time, if (as it frequently happens) the Moon Dial be composed of 3 *Centrical Circles*, whereof the last and greatest be that of the Moons day, the next to it the hour Circle, and the inmost the *Index*; let the Index be applyed to the day of the Moon, and then by that Circle, observe what hour, or part of an hour the shaddow marks, and you will find the true content.

Planimetry,

Planimetry, or, The most Exact and Curious Arts of Surveying Lands, &c. after the newest and most Experienced Method and Practice, &c.

PLanimetry, or *Surveying*, is numbered among the Curious, and deserves worthily here to take place; and to be exact in this, have (beside other Instruments proper to the matter) a Ruler of about 7 or 8 Inches long, and an Inch and a half broad, and place two Scales, one of 12, and the other of 11, in an Inch describing a line of Cords 2 Inches long, or somewhat less than 60 or 90 degrees, the *Radius* of which or 60 degrees, being equal to the *Semidiameter* of the same Circle, and after the order of these on the other side, place several other scales which may be of 16, 20, 24, or the like in an Inch, whereby you have an Instrument necessary for sundry occasions, and for this scale in its use you must be provided with a pair of Brass Compasses, also a curious pair of Calem Compasses, having screws to alter the points, as to draw as occasion requires to the beautifying the *Plats* with black Lead or the like; being provided with Instruments, and all things fitting for measuring, you must consider the Measures, and reduce that which is called Sta-

tute Measure into such measure as is Customary and Usual, for by an Act of the 23 of *Edward* the I. an Acre of Land was to contain 160 Perches or Poles to be made out square, &c. but by Custom in divers places of this Kingdom, this has been altered by the varying of Perches in the number of feet, as, 18, 20, 24, and sometimes 28 foot to the Perch, and this requires the Surveyers diligence to reconcile the one to the other, of which we shall give some insight.

Suppose you are to Reduce 5 Acres, 2 Roods, 20 Perches measured Statute measure by 18 foot the Perch, in this case seek the least proportional terms between 18 and 16 foot and a $\frac{1}{2}$, and to effect it, because the latter carries with it a fraction, reduce it into halves, and that they may be of one denomination, let the 18 foot be likewise halved, and you will find them in this manner $\frac{3}{36}$, which you must abbreviate by 3, in saying, how many times 3 shall I find in 33, and the Answer will be 11 times 3, and the same do by 36, and you will find it 12 times 3, and thereupon the two proportional terms between 16 $\frac{1}{2}$ and 18, will appear to be 11 and 12 which being done, reduce the Given Quantity of 5 Acres, 2 Roods, and 20 Perches all into Perches, by which means you will find them to be 900 Perches; then observe what is the *Proportion*, the Square 11

which

which is found 121, bears to the ſquare 12, which is found 144, the ſame does the Acre containing 16 and a half feet to the Perch, bear to that that contains 18 feet to the Perch or Pole.

Always obſerve, in this was particularly that the greater meaſure is to be reduced into the leſſer, then multiply the Quantity Given, *viz.* 900 Perches by 144 the larger ſquare, and you will find the Product to be 129600, and that divided by 121, you will find the Quotient to be 1071 Perches, and $\frac{9}{121}$ parts, which reduced into Acres, gives us 6 Acres, 2 Roods, and 31 Perches, and $\frac{1}{121}$ parts of a Perch, and this compeers with the Quantity of Acres *Parallel* with Statute meaſure; but on the other hand, if it had been required for the reducing Statute Meaſure into Cuſtomary Meaſure, you muſt then Multiply 900 perches, your given meaſure or quantity, by 121, which is the leſſer ſquare, becauſe the leſſer is to be reduced into the greater, and you will find the Product to be 108900, which if you divide by the greater ſquare 144, you will have the *Quotient* 756 $\frac{1}{4}$, which being reduced into Acres, is 4 Acres, 2 Roods, 36 $\frac{1}{2}$ Perches; and this rule is to be taken with what ever Cuſtomary quantity is propoſed in their differences, and degrees, as when the Perch is 20, 24, or 28 foot, or other diſproportions of number.

If in this Menſuration, you are required to reduce Perches into Acres, and ſo on the contrary, obſerve that by the Aforementioned Statute, an Acre of Ground ſhould contain 169 ſquare perches or poles, being every Rood 4 ſquare perches, ſo that if you find any number of perches, that muſt be done into Acres, the given number muſt conſequently be divided by 160, and the Acres are ſhewed by the Quotient, but if there be any remainder, and it be under 40, they are perches, but if they are found to exceed 40, divide by 40, which you will find to be the number of perches contained in a Rood, ſo that the Quotient will be Roods, and the Remainder Perches.

But to reduce Acres into Perches, there is no great difficulty, conſidering it is but turning it as it were backward, for in the other to bring Perches into Acres, the diviſion was by 160, but in this caſe, to turn Acres into Perches, it muſt be multiplied by 160, which being obſerved, we come now to more nearer particulars, as to the matter in hand. If the piece of ground you meaſure be ſquare, having conſidered well that the Acre is 160 Perches, then multiply one of the ſides by the other joyning to it, & you will find the ſum is to be divided by 160, and ſuppoſe your Ground be 40 poles one way and but 20 another, theſe multiplyed, make 800 Poles or Perches,

ches, which divided by 160, shews 5 Acres to be the content.

In measuring a Triangular piece of Ground, you must first observe to measure the longest side of the Triangle, as also the Perpendicular opposed to the said long side, then multiplying the half of one by the whole of the other, you must divide by 160.

Suppose the side be 60, the Perpendicular 40; 60 must be multiply'd by 20, or 40 by 30, which so done, make 1200, which being divided by 160, renders 7 Acres and ½ for the true content.

If you are to measure that which we call a Trapezia, or a double Triangle, then both the Perpendiculars must be multiply'd by the Diagonal Line, as being the usual or common Base of both the Triangles, and must be divided by 160 in this manner. Let the Diagonal Line be 40, and one of the Perpendiculars 15, the other 8, which being put together make 23, which being multiplyed by 20, which is half the Diagonal Line, make 460, and that divided by 160, renders two Acres, three Roods, and 20 Poles.

If the Ground be Circular, then half the Diameter must be multiplyed by half the Circumference, and the product divided by 160, whereby the Diameter of the Circle being found to be 140 poles, the Circum-

ference is 440 poles, and the half of these two producing 220, and 70, they are to be multiplyed together, and then produce 15400 Perches, which being divided by 160 produce 96 Acres and a ¼.

If the piece of Ground given, be Oval, suppose it to be 30 Perches one way, and 40 the other, to know the content: multiply the length 40 by the bredth, which as aforesaid is 30, and you will find it make 1200, which again divided by 203 $\frac{1}{10}$, and you will find it yield 5 Acres, 3 Roods, and 23 Perches, and by this last number so working, you may find the number of Acres contained in a Semicircle, a quarter or sixth part, or any section or division of a Circle greater or lesser, multiplying the half Diameter.

If you are to measure wood Land, which is the difficultest of all, you may fix a mark at either corner of the Wood, that 3 marks may be seen at once, then having a Quadrant in your hand, lay it flat thereon, and take sight to two of the marks on each side, and then upon paper, mark the degrees of the Angle, and measure to the two marks in sight, and place them on the same paper by your line of equal parts, and do so to all other corners, till you have closed up the Plat or Wood, which then may be easily brought into Acres by the line of equal parts. And Note here, if you

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Quadrant be too small, you may joyn two together, or do it by a board for want of a plain Table, so your Plat upon the paper make 3 Triangles, and to measure one of them, measure for one Triangle the longest doted line, by half the middle doted line, or Perpendicular, which gives the content, and by so working the other two Triangles you have compleated it.

The

The Art and Mystery of Gauging Vessels *of Sundry Forms and Quantities, by Exact Rules laid down plain and easie: Also to* Gauge *and know the Burthen of any Ship, and other matters.*

Gauging is very necessary to be understood by all People that deal in Commodities, wherein *Casks*, or the like, give the Dimensions of their Measure; wherefore, for their better Instruction in this Art, there are two things principally to be considered: First, That seeing Vessels are mostly of Irregular Forms, it must be the care of the *Ganger*, to consider how they are to be reduced to Regular Proportions; and, in the Second place, to inform himself, of the true content of the Gallon in Cubick Inches, or parts of a Foot; and for the first of these, carefully Measure the Diameter of the Cask at the Bung and Head, and, by those Diameters, to find out the Area of their Circle, and so take 2 thirds of the Area at the Bung, and 1 third at the Head, which, being added, will be found to be the mean Area of the Cask; and if you multiply that Area by the length of the Vessel, it will shew how many solid Inches are contained in that Vessel,

Vessel, which being divided by the number of Cubick Inches in one Gallon, the Quotient will demonstrate what number of Gallons the Cask holds.

As, if we suppose that a Vessel of Wine be 18 Inches Diameter at the head, and 32 Inches at the Bung, the length being 40 Inches, if you would be satisfied in the content, consider, that one third of Area at the head, is found to make in its due proportion ——— 85, 823

And two thirds of the Area of the Bung, make ——— 536, 166

And then consider the sum of the two, to be ——— 620, 909

When Multiply'd by the length ——— 40.

Makes Inches solid ——— 24819, 560.

These being divided by the solid Inches in one gallon of Wine, they being 231 Inches for the content, yield 190 Gallons, 530 parts, which is some small matter above half a Gallon, yet some raise a dispute about the certain number of Inches in a Gallon, yet the Wine Gallon is generally concluded to consist of 231 Cubick, or solid Inches, and the Ale Gallon is held by many in Computation with the Wine Gallon, as 4 to 5, so that in such a degree of difference, it must be 282 ⅔ Inches, but upon the imposition of Excise, it has been

generally Esteemed but 282 Cubick Inches.

If you would know the content of any Wine or Beer in Ale or Beer Gallons, observe for the Beer Barrel.

The diameter at the head 9 inches, 9 parts
For the diameter at the Bung, 23 inch. 0 parts
The length ——— 27 inches, 4 parts

The Kilderkin has for its measurings.
The *diameter* at the head, 16 inches, 1 part
Its *diameter* at the Bung, 18 inch. 6 parts
The Length ——— 12 inches, 1 part

And these are called the Coopers scantlings, and very well agree with the received quantity of the Ale Gallon, allowing it to be 288 Inches and a half, so that the Barrel this was reckoned to be a Pint over 36 Gallons, and a Kilderkin a Pint and a half over the half of that, though as I have said, this Gallon has lately been agreed upon by a Committee of Excise, to hold no more than 282 Cubick Inches.

Now to measure Brewers Vessels, &c. whether they be Square or Round, or of any other form: First, to know their true Content, observe what has been said in Measuring such Bodies, dividing by 282 the inches in one Gallon, demonstrates the content in Gallons, and if you divide the Gal-

lons

lons by 36, the contents in Barrels are shewed, and so by knowing the true number of Inches, any measure is to be taken.

If you would know the Burthen of a Ship, or how many Tun she will hold, or Commodiously carry: First, inform your self by measure of the length of the Keel, and take the breadth at the Mid-ship beam, and the depth of the Hold, and these three you must multiply one by the other, then the product thereof must be divided by 100, and so the Tuns of Burthen will be plainly demonstrated.

As, granting the length of a Ships Keel to be 50 Foot, and at the Middle-beam her breadth 20, and the depth in the hold ten foot, then to know how many Tuns she will carry, let 50 be multiplied by 20, and it makes 1000, and that again multiplyed by 10, makes 10000, the which, when divided by 100, and cutting of the two last Figures, it shews the Ship to be 100 Tuns of Burthen; but this way is usually attributed to *Men of War*, but for *Merchant Ships*, they give no Allowance for Masts, Sails, Ordnance, and Anchors, the which, though they are a Burthen, yet are not accounted Tunnage; wherefore, as to *Merchant Ships*, your product must be divided by 95, and then a Merchant Ship, of the aforesaid length, breadth, and depth, will be found 105 Tuns $\frac{1}{2}$ parts Burthen, though there must

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must be regard had in this case, to the middle of the Ship, for fear of Erring, and if you are doubtful whether you are right or not, if the Ship be Irregularly built, find out how many Cubick Feet it contains, and Reckoning that a Cubick Foot of water, weighs, as it is generally accounted, 55 *Averdupois*, or 16 ounces to the pound, so that consider 2000 weight being allowed to the Tun, and every hundred 112 lb. the Dimensions must be taken accordingly, and by this Rule you must take your proportion: But to come sure of this another way;

Measure on the out side the Ship to her Lightmark, when she is in the Water unladen, and there you will find the weight or content of the Empty Vessel, so that if you take your measure from her Lightmark to her full draught of Water, being Laden, you have the true Burthen of her Tunnage. Also, if you're desirous to know the Burthen of another Ship double or treble of the same Mould, or a greater or lesser proportion, multiply the measure of the Length, and Breadth, and Depth Cubically, after that is done, double or treble the Cube, and Extracting the Cube Root, your work is done, and so you may go on to other matters of this nature, or any other belonging to *Gauging*, which your Rules and Instruments of direction will furnish you, in your proce-

dure.

dure, when you are once thus far entered, and by degrees it will become easy, if you cast a Method in your mind.

Exact Rules and Directions for Fortification, Regular and Irregular for War, Offensive or Defensive, Outworks and Inward Strengths, &c.

FOrtification is of great moment, and in the well observing and Regular performing it for defence and offence, many times consists the Safety of Countries and Kingdoms, however the Scituation and Circumstances require much Variation, so that to prescribe the Models of all Fortifications would be Endless, and therefore it will be most convenient to treat of the modern, or those most generally in use.

Observe then of this kind, your works require to be Flanked to keep the Enemy from a sudden Entrance, where any Breach is made by the great Guns, for if the Besiegers have made their approaches so near, that the Besiegeds Cannon in the Front are dismounted, then you may be assured their design is to put their Miners to pass the Ditch, and then if they perceive any place out of sight of the Besiegeds firing, they will have an opportunity to make their

Mines with little difficulty, so that a place unless the Garrison be very Large to make frequent Sallys, may be taken in 8 or 10 days, that with Flankers might hold out much Longer, so that it has been the practice of late to turn the Antient Round Bastions into sharp pointed ones, which not only upon occasion serve for Flankers to defend against any hasty approach, but to flaunt and hinder the force of the great Shot playing against the Town or Fort.

Amongst other things necessary on this occasion, the great Line of defence is to be considered, or what may be found near Equal into it, *viz.* the *Polygon Interior*, which ought not in most cases to exceed 120 Fathoms, or 720 Feet, and this is found to be a point blank of the Execution of a Musquet, the Cannon being here Incommodious, and therefore the defence is to be taken from the former, the latter beside the waste of Ammunition, lying much lyable to be dismounted, and not so easily again remounted, as the Emergency requires, and the difficulty is likewise greater in maintaining a continual Fire, and if the work be not incommoded by their over largeness, the more Capacious, the Gorges and Flanks are, the better will the Fortification be found for defence, for then the Soldiers may pass to and fro in a good front to the Bastion, when Cannon is planted on both sides

sides the Flank, and give no interruption to those that are at the Flanks, and if there be but a supposed necessity required, there must be a vacancy left for Retrenchments, and a place under the Bastions left fit for Mining, that if it come to extremity when you have drawn off as soon as the Enemy has possessed the Bastion, it may be blown up, & their Attacque cleared till the Besieged may know what is further to be done in the defence of the place, and draw their strengths from other parts thitherwards.

Above all, the Curtain Flanks and Faces of the opposite Bastion are to be well secured and guarded, as likewise the Ditch and Counterscarp being made as large as the due proportion of the Bastion will allow, for if they be too great, their Capitals will be found too long, and thereupon the defence Line exceed the Port of any Musquet, or small piece and being too little they will become blunt, and so cut off the second Flank, whilst it ought to be held considerable.

The degrees of the Angle of a Bastion, ought not to be less than 60, or more than 90, some small matter allowed over or under; and the reason is, if it be much under 60, it will be found too slender, or above 90 too large, or more than may be well supplyed; and moreover, by that the second Flank is shortned, and it will be computed

in less Ground than the Bastion, where it is an Angle of less degrees, though built on the like Gorge and Flanks, and observe in all your works to let them be Cannon proof.

If we proceed to a description of *Regular Fortification*, it is to be understood of such *Models* as are equally *Angular*, and founded upon *Equilateral Figures*, to be described in a Circle, as it may be a *Triangle*, *Quadrangle*, or a *Quartil Pentagon*, or a Figure of 5 sides to a *Dodecagon*, or a Figure of 12 sides, and in this case the Bastion must be so posited, that all the points may answer in like distance from the Centre. The Curtains of Equal Length, and all the Angles and Lines to be of an equal Magnitude for *Regular Models* are to be computed from a Calculation of the Angle at the Centre, and that is done by dividing 360, the number of the degrees that a Circle is usually divided into, and wherein the Regular Figure is to be described by the number of any Polygons sides, or the Regular Figure, that any Fort or Work of War of this nature is to consist on; for hereby the Quotient demonstrates the Angle of the Centre, as may be demonstrated by a Figure of five sides, wherein by operation, the Angle of the Center is certain to be 72 degrees, and the like of any other figure, then if you draw a Circle with

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the Protractor, or Line of Chords, the first being a Semi circle, and the last the fourth part of a Semi-circle, or 90 degrees projected on a straight line, and the Angle beset off at the Center at 72 degrees, the Circle will thereby be divided into 5 equal proportions, or parts, and the straight line drawn to the points, produces a Pentagone. Besides this *Model of Fortification*, there are sundry Outworks required for strengthening a place, they hinder much the Besiegers from making their Lodgments if the ground happen to be low near the Counterscarp, or from suddeinly raising Batteries by the advantage of that ground, if it happen to be high; wherefore a careful Enginier always provides Outworks to hinder it, and prolong the approaches to the main Fort, and these Outworks are various as the Situation of the place, or the danger requires.

Ravelins, being an usual Outwork, they are usually of two kinds, one with lines, and the other wanting; the first of these are placed before long Curtains, where the two Bastions are not capable of Flanking each other within Musquet shot, and the length of the Curtain not sufficient for the erecting a Plate Bastion in its Center, and supply the defect of a Bastion by covering and defending, and to erect these kind, the Ditch must be cut parallel with

the Curtain, and above it erect a Capital from 18 to 20 Poles, and let your *Demi-gorges* be no more than from 10 to 12 Poles the Flanks, from 8 to 10, the Ditch surrounding them, and the greatness of the Flanks Parallel to the face of the Ravelin till the ditch of the place of the face of the Bastion be met by it, that so the Ravelins Flanks may scowr over all the ditch that faces the Bastion.

The Ravelins without lines, consist only of a Capital and two faces, the Capitals from 12 to 18 Poles the face, e'ging or drawing nearer to the shoulders of the Bastion, that within the Ravelin may be commanded by the Curtain and two Flanks.

The half Moon is a work ever raised before the Bastions point, being so named from the lowness of its Gorges Cavity, &c. and is to secure the two faces of the Bastion, but when the faces have but a weak defence from the *Ravelin*, these works are soon made useless, or ruined, and give the Besieged an opportunity of Lodgment, & may serve for Batteries and Flanks against the opposing Bastions, however, they may be retrenched by Traverses, yet they will not fail to attacque entirely in the face, or where you have your last retrenchment, also, that called the *Counterguard* runs the like hazard.

The Outworks, called the *Hornworks*, are placed before the *Curtains*, a *Perpendicular*

Line

Line being drawn from it at the two Flanks about 60 Pole front, towards the *Campaign*, their front to be 36 Poles, equal to the *Curtain*, to be divided into 3 Parts, one of them for the *Curtain*, and the other for the *Demigorges*, appertaining to the *Hornwork*, as for the Flanks, they are to be six Rods, or 72 foot each, and this work is held one of the best and strongest Outworks, if well manned and managed, especially when a Ravelin is placed before it.

The Outworks called the *Tenalis*, is built to secure the Bridge when it is hard pressed upon their sides, containing 50 Poles, and the Fronts no more than 36, which being divided into 4 equal parts, a Perpendicular is drawn in the middle, whereon a $\frac{1}{9}$ of the front is set off inwards towards the Town, and the Lines must be drawn from the sides, to form the face; this work is advantageous for *Counter Approaches*, and for receiving succours into the Town.

The *Crownwork* is usually erected, a when heighth is so near to the place, that a *Musquet* shot may reach it, and then the sides of the works must be extended before the Bastion, or *Curtain* about 65 Poles, & the *Demibastions* point to be about 60 degrees, then the Extremities of the sides must be joyned, and a *Perpendicular Line* raised on the middle, on which fix, for the *Capital*, 18 Rods, making an Angle of two Interiour Polygons.

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